FEASIBILITY OF SUPPLYING HYDRO POWER

TO MOSES INLET, B.C. FORESTRY CAMP UNDER CONTRACT

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SUMMARY

The Moses Inlet Camp is a modern, 70 man logging camp located on the central coast of British Columbia operated by Crown Forest Industries Ltd. It presently depends on a diesel generating plant for power, comprising 2 - 100 kW units, and because it has electric water and space heat the potential use of fuel is high. The camp is located near a potential hydro power site, and this report evaluates the feasibility of developing that site.

There is nothing unusual about the situation at Moses Inlet, because it occurs frequently on the coast of British Columbia. What is unique is the approach that an outside investor would develop the hydro power site and sell power or generating capacity back to the logging camp. This approach requires a more careful analysis of the camp loads, local hydrology and operating characteristics to ensure that a project is sized to make the project sufficiently attractive to the investor. This must occur without sacrificing the operational convenience of the camp.

In this report, the camp loads have been analysed based on the known electric devices installed and the projected occupancy of the camp. The logging camp operates on a repetitive daily pattern, hence the loads are defined in increments representing sleeping hours, breakfast, work day, cleanup/dinner, evening/laundry and late evening. The loads are calculated for an unregulated case (no energy management) and a regulated case, where energy management is used to avoid the peak loads (especially on water heat) by gradual heating and storing energy throughout the day.

The local hydrology is based on regional records as there are no streamflow or rainfall records at Moses Inlet. However the rainfall pattern in this area of the coast is relatively consistent (and heavy). The subsequent analysis accounts for the long term expected flow variations on a monthly basis.

The operating characteristics of a potential diesel/small hydro system have been considered in the study. Important considerations are situations when flow is limiting or when installed capacity of the hydro power plant is limiting. During these situations the diesel generation plant must be utilized and in order to properly operate the diesel plant some additional load may have to be relinquished to the diesel by the hydro power plant.

The project is designed as a relatively simple intake/penstock/powerhouse system with a short transmission line to the camp. Several component sizes were costed to establish a range of costs for different installed capacities.

The optimal plant size was evaluated over a broad range, then load options were applied over a narrow range. This has been done by establishing a base case of 20 different plant sizes to determine the range of least cost options (based on cost per kilowatt hour). These were subsequently tested with other design variables to ensure that the lowest cost option was still valid. The apparent optimal size plant is 90 kW with a fully occupied camp, but the cost of other plants from 75 - 100 kW varies over a narrow range (0.25¢/kW.h) so that other considerations (eg. convenience or a special price on a particular component size) may result in the selection of a different installed capacity within the determined range. Smaller camp sizes favour a lower installed capacity, with 75 kW being the lower limit.

The final task of the study was to provide a financial analysis to guide the investment decisions, and enable an equitable Power Sales Contract to be evolved between Lancaster and Crown Forest. The financial analysis considers such features as: the expected life and staging of the logging camp; the likely long term work force of 40 men based on detailed discussions with Crown Forest; the effects of energy management; and technical requirements for load sharing between the hydro/diesel system. The installed capacity was determined to be in the range of 75 kW to 90 kW with a gross head of 105 metres, subject to final negotiations, which will provide electrical energy needs of 70% to 73% of the total camp requirements at a price which is less than the cost of diesel generation. The existing diesel generation plant comprising 2 - 100 kW units will still be required to provide standby and peaking capacity, but the planned purchase of an additional 100 kW unit will not be required.

FAISABILITE DE FOURNIR DE L'ENERGIE HYDRO-ELECTRIQUE SOUS CONTRAT AU CAMP DE BUCHERONS DE MOSES INLET (C.-B.)

Résumé

Le camp de bûcherons de Moses Inlet est une installation moderne pour 70 bûcherons située dans la partie centrale de la côte de la Colombie-Britannique et exploitée par la Crown Forest Industries Ltd. Deux groupes électrogènes diesel de 100 kW chacun fournissent actuellement l'électricité au camp; la consommation de carburant diesel est élevée parce que l'eau et les locaux sont chauffés à l'électricité. Le camp se trouve à proximité d'un site à potentiel hydro-électrique; le présent rapport évalue la faisabilité d'aménager le site en question.

Il n'y a rien d'extraordinaire dans la situation qui prévaut à Moses Inlet; elle se retrouve fréquemment sur la côte de la Colombie-Britannique. La particularité du cas étudié découle du fait qu'un investisseur de l'extérieur (Lancaster Resource Corporation) se propose de mettre en valeur le potentiel hydro-électrique et de vendre l'électricité ou la capacité de production d'électricité au camp de bûcherons. L'approche exige une analyse plus détaillée des charges, de l'hydrologie locale et des caractéristiques d'exploitation afin de fixer l'envergure du projet à une échelle où il sera suffisamment intéressant pour l'investisseur. Il ne faut pas pour autant sacrifier la commodité d'exploitation du camp.

Dans le présent rapport, on analyse les charges électriques du camp selon les appareils électriques qui sont en place et selon le nombre prévu d'occupants. L'exploitation du camp de bûcherons suit un horaire quotidien répétitif et les charges sont définies en tranches qui représentent les heures de sommeil, le petit déjeuner, la journée de travail, la toilette/le souper, la soirée/la lessive et la fin de soirée. On a calculé les charges pour deux cas distincts: l'un sans aucune réglementation (pas de gestion de l'énergie) et l'autre, réglementé, comportant la gestion de l'énergie pour réduire les charges de pointe (surtout dans le cas du chauffage de l'eau) par un chauffage graduel et un stockage d'énergie pendant toute la journée.

L'hydrologie locale est fondée sur les relevés régionaux, puisqu'il n'y a pas de relevés sur l'écoulement ni sur les précipitations à Moses Inlet. Les précipitations dans le secteur sont toutefois relativement égales et fortes. L'analyse qui suit tient compte des variations mensuelles à long terme des débits prévus.

Les caractéristiques d'exploitation d'un petit système mixte hydro-électrique et diesel sont examinées dans l'étude. Comme facteurs limitatifs il y a d'une part le débit et d'autre part la capacité hydro-électrique installée. Dans ces situations il faut utiliser le groupe électrogène diesel. Afin d'assurer le bon fonctionnement de l'installation diesel il faudra peut-être confier une part additionnelle de la charge à celle-ci.

Le projet est étudié sous forme d'un système relativement simple de prise d'eau, conduite d'amenée et salle de machines avec une courte ligne de transport au camp. On a déterminé les coûts de composants de plusieurs dimensions pour établir une gamme de coûts pour différentes capacité installées.

La capacité optimale de la centrale a été évaluée sur une gamme assez vaste, et les options de charge sur une gamme étroite. On a déterminé un scénario de base comportant 20 différentes capacités installées afin d'en déduire une gamme d'options à moindre coût (coût par kilowatt-heure). D'autres variables de calcul ont ensuite été appliquées pour tester la validité de l'option au coût le plus faible. La capacité installée optimale semblerait être de 90 kW dans le cas d'un camp hébergeant le nombre maximal d'occupants. Le coût de l'énergie d'autres installations dont la capacité va de 75 à 100 kW varie cependant dans une fourchette étroite (0,25 cents par kW.h), et par conséquent d'autres facteurs (par exemple commodité ou un prix spécial offert pour une dimension particulière) pourrait conduire au choix d'une capacité installée différente dans la gamme déterminée. En cas de taux d'occupation plus faibles, les capacités installées moins élevées (jusqu'au minimum de 75 kW) sont plus intéressantes.

La tâche finale de l'étude était de faire l'analyse financière pour servir de guide aux décisions d'investissement et de permettre l'élaboration d'un contrat équitable de vente d'électricité entre Lancaster et Crown Forest. L'analyse financière tient compte de points tels que: la durée de vie prévue et les phases d'exploitation du camp de bûcherons; le nombre probable de 40 travailleurs à long terme, fondé sur des entretiens détaillés avec Crown Forest; les effets de la gestion énergétique; et les exigences d'ordre technique découlant du partage de la charge entre les systèmes diesel et hydro-électrique. Il a été déterminé que la capacité installée se situerait dans la gamme comprise entre 75 kW et 90 kW, avec une hauteur brute de chute de 105 m, sous réserve de négociations finales; cette solution suffirait à satisfaire aux besoins en énergie électrique du camp dans une proportion de 70 % à 73 % à un prix inférieur au coût de production d'électricité par le groupe électrogène diesel. Il faudra garder l'installation actuelle de deux groupes électrogènes diesel de 100 kW pour fournir la capacité de secours et de pointe, mais il ne sera pas nécessaire de procéder à l'achat prévu d'un groupe additionnel de 100 kW.

Cette étude a été effectuée par Sigma Engineering Ltd. pour Lancaster Resource Corporation à l'aide d'une subvention du Programme de démonstration dans les collectivités éloignées d'Energie, Mines et Ressources Canada.

1. INTRODUCTION

1.1 THE RELATION BETWEEN HYDRO POWER AND THE FOREST INDUSTRY

Hydro power and forestry have been associated since the early 1900's in British Columbia when both industries were in their developing stages. Small logging operations typically consisted of harvesting and processing together, and a small turbine or water wheel might be used to operate a saw for lumber production. As both hydro power and forestry developed they combined similar patterns of expansion with increased economies of scale.

Hydro power plants became larger and prime sites were developed to be linked to the load centers by long transmission lines. Similarly forest product processing became more centralized, with larger mills producing lumber and paper in export quantities. These plants were tied in to the transmission grids, notable exceptions being Ocean Falls and Port Alice which relied on adjacent hydro power sources.

In the meantime, timber harvesting operations remained small and decentralized. The camps developed with the idea of portability and ease of assembly, hence the portable diesel generator was ideally suited to these qualifications. For a time, relatively low prices of diesel fuel led to inexpensive costs of electrical generation.

The situation in the 1980's is considerably different. Camps are being developed with 20 year lifespans, while diesel fuel, which increased in price dramatically during 1973-1982, has taken an increasing share of the operating budgets of logging camps. Despite the improving economics of small hydro power developments there are still relatively few camps which are operating small hydro plants. Part of this situation can be explained by the severe economic hardship the industry has faced in recent years placing limits on capital expenditure.

1.2 BACKGROUND TO THE MOSES INLET CAMP

The camp at Moses Inlet was first established in 1981, and although it is of typical size to camps along the coast, its situation is unique in many respects as detailed in Section 2.4. In terms of its energy use the camp is dependent on diesel generation, and because the camp uses electric space and water heaters the base load is relatively high, which is attractive to the economics of a small hydro power plant. The proximity of the camp to a potential hydro power site led to its being noticed during studies as part of the Remote Community Demonstration Program, sponsored by Energy, Mines and Resources Canada.

The proposal to study the site was made by Lancaster Resource Corporation who would develop the hydro power site for sale of electrical service to the camp owner, Crown Forest Industries Ltd. Using the guidelines of Stage 1 of the Remote Community Demonstration Program which provided funding for off-oil feasibility studies, Lancaster developed a funding formula that was acceptable to Energy, Mines and Resources Canada and to Crown Forest

Industries Ltd. The basis of the study is to provide Lancaster with sufficient information to evaluate the diesel fuel displaced and make an investment decision with regard to the hydro power development. Various features of the camp which make it a suitable investment vehicle are described throughout the report.

The first stage of the project, a Study of Site Feasibility, was completed in December 1983. An interim report was prepared which described the results of a field inspection on December 12/13, 1983 and preliminary calculations of the power plant parameters were presented. The results were favourable, and authorization was given for Stage 2 of the study to proceed comprising the conceptual design, project cost estimate, design optimization and financial analyses to ensure that the optimal hydro power plant for investment purposes is established.

1.3 TERMS OF REFERENCE

In an agreement dated December 9, 1983, Lancaster Resource Corporation authorized Sigma Engineering Ltd to proceed with Stage 1/2A of the project in accordance with the modified proposal dated December 7, 1983. The report was submitted on December 30, 1983. Subsequently, on January 1, 1984, Sigma Engineering Ltd were authorized to proceed with Stage 2B of the study. The detailed terms of reference comprising the Scope of Work are described below.

1.4 SCOPE OF WORK

The scope of work as outlined in the terms of reference, the consultant's proposal and the subsequent agreement, is as follows:

Stage 1/2A

Site Reconnaissance, covering an inspection of the camp and potential hydro power sites.

Hydrology, covering the stream flows, rainfall and preliminary energy availability of the site.

Load Demands, covering the expected average energy usage at the camp.

Report on Site Feasibility, describing the results of the site reconnaissance, hydrology and load studies with a preliminary indication of the project economics.

Stage 2B

Hydrology, updating previous information.

Scheme Sizing, to determine the optimum size of plant considering available energy and load demands.

Scheme Layout to take advantage of the topography.

Conceptual Design of the intake, penstock, powerhouse and equipment.

Project Cost Estimate

Financial Analysis to assess the feasibility of the project from the perspective of Lancaster as the potential investor which could develop the hydro power resource and enter into a Power Sales Contract with the forestry company. This will include a comparison of the costs of the hydro power project with the existing diesel operation.

Stage 3 (by Lancaster)

Investment Risk Assessment

List and assess the various investment and business risks faced by Lancaster and a forestry company (eg. risks due to volatility of forest products markets, oil prices, and other external variables). Test the sensitivity of the project to these variables.

Power Contract Options Review

With the aid of legal counsel identify the major provisions of the power contract between Lancaster and the forestry company.

Report

Prepare a draft report for comment by Energy, Mines and Resources Canada. Prepare a final report which takes any comments into consideration.

The final report will contain:

- table of contents
- executive summary
- background
- scope
- description of proposed hydro power development
- power supply and demand
- cost estimates
- financial analysis
- investment risk assessment
- power contract options
- findings and recommendations
- information transfer potential
- bibliography and/or references

2. PROJECT AREA

2.1 AREA LOCATION AND DESCRIPTION

Moses Inlet is an arm of Rivers Inlet located about 130 km north of Port Hardy on the central coast of British Columbia. The inlet itself is about 26 km long and 1 km wide. The camp referred to in this study is owned by Crown Forest Industries Ltd on special use permit land (granted by the Ministry of Forests) at Eberts Cove, 5 km south of the head of the inlet on the east side.

The surrounding land is typical of the coast, with mountains rising steeply to 1200 m elevation and dense coniferous forests. The land at the camp is flatter than the usual terrain because it lies in a small valley between two mountain ridges. A creek having two tributaries, one with lake storage, flows by the camp and is the site of the proposed hydro power plant.

2.2 ACCESS

Access to Moses Inlet is provided by scheduled float plane service as well as charters. An air strip has been constructed by the forest company at the head of the inlet. Heavy goods would be moved in by barge.

Access to the proposed hydro power site is by existing gravel road from the beach near the camp to about half way along the penstock route. The penstock route above this point parallels the creek and will require improved access prior to construction. Considerations of any works above the creek towards the lake will involve alternative access plans (ie. on foot or with helicopter) as the slopes are too steep for road construction.

2.3 CAMP DESCRIPTION

The Moses Inlet camp is one of the most modern facilities in the British Columbia forest industry. The main camp building is situated on a level bench at about 10 metres above sea level. It is laid out about a central core with the kitchen, dining area, recreation room, offices, lounges electrical room, dry room and laundry running from west to east. Extending from the common areas are the 71 sleeping rooms, which are mostly built in 8-room modules. The existing diesel generating plant is temporarily located between two of the wings in its own shelter.

The buildings are modular, factory built by Artisan Manufacturing Ltd. They feature 2 x 4 wall construction with R12 insulation, low pitch roofs with R24 insulation, R12 floors and double glazed windows. Doors are all weather stripped and metal cladding is used on the exterior. The building layout is shown in Figure 2.

Water to the building is piped from an adjacent creek (not the creek proposed for hydro power) and is piped to all extremities of the building. The sleeping rooms have one bathroom for each pair of rooms while each group of 8 rooms is served by one 100 gallon water heater. Other users of hot and cold water are the kitchen area and the laundry room. Details of the camp loads are provided in Section 4.1.

There are plans for a maintenance facility to be located south of the camp on a level cleared area between the road and the creek, however the exact details are not known yet. Provision has been made to use generator waste heat to heat the building, while most other operations would be electric.

In relation to the buildings the penstock of the hydro power plant would pass close to both facilities. The size of the penstock and the pressure near the buildings would allow the water to be used for both domestic water and fire flow supplies.

2.4 EXISTING ELECTRICAL GENERATION FACILITIES

At the present time the camp is operated with two 100 kW diesel generators run alternately. Future plans call for a third generator to be used on standby while two generators are run in parallel. Up to the present time there has only been a need for a single generator as the camp has never run at full occupancy due to the necessity of developing the area before full scale logging occurs.

The output from the generators passes through the electrical control room in the camp complex. Here there are breakers serving most of the major circuits in the camp. Because there are many high electrical loads in the camp (water heaters, baseboard heaters, driers and kitchen equipment) there are numerous electrical panels.

The diesel fuel used at the camp is transported to the site by fuel barge and pumped into large tanks for use by both the generators and the equipment. There is presently no separate metering to determine the quantity of fuel used for each purpose. Crown Forest pay $0.37/l for fuel delivered to the site, and there are additional costs absorbed to transport the fuel from the main tanks to the diesel generator tanks. Based on an average burning efficiency of 3.0 kW.h/l and a maintenance allowance of 1.5¢/kW.h the average cost of the power is about 15¢/kW.h, not including the capital cost of the machinery. These details are shown in the following table.

TABLE 2.1
COSTS OF DIESEL GENERATION
CROWN FOREST : MOSES INLET CAMP

	1982	1983	1984 (Projected)
Fuel and Lubes	$ 32,780	$ 46,333	$ 70,000(1.)
Repair - Bella Coola	953	615	800
Moses - Labour	192	1,412	1,500
Material	76	284	300
Repair Materials		839	1,000
Preventive Maintenance Checks		1,063	1,000
Repair Materials - Finning	1,771	5,150	3,000
Filters	468	249	400
*Major Overhaul @ 18,000-20,000 hours	5,000	5,000	5,000
TOTAL	**$ 40,340**	**$ 60,947**	**$ 83,000**
Estimated kW.h	353,000(1.)	453,000(1.)	543,000(1.)
Cost per kW.h	11.4¢	13.5¢	15.3¢

*With generators alternating most of the year, the overhaul should come every 4 years and is prorated on an annual basis.

Average Amortization Cost (20 years @ 12% = .1338)

Assuming 1 machine averages 50% load
Annual Cost = $40,000 x .1338 = $5,352
Annual Load = 438,000 kW.h

Amortization Cost = 1.2¢/kW.h

Source: Crown Forest except as noted:

(1) By Sigma Engineering Ltd

3. HYDROLOGICAL INVESTIGATIONS

3.1 REGIONAL HYDROLOGY

There are no site specific rainfall or streamflow measurements available at Moses Inlet, hence regional data must be used. The nearest rainfall data are available from Namu, 30 km to the west, which has a standard 30 year average of 2500 mm (100 ins) of precipitation. Regional precipitation maps showing isohyetal contours place Moses Inlet in a region with higher precipitation than Namu.

The nearest streamflow data is from the Sandell River near its mouth at the Wadhams Cannery some 30 km south of Moses Inlet. The flows recorded span the period from 1923 to 1932 and the mean annual runoff, after correcting a published error in the Water Survey Catalogue, was 3000 mm/year with a 10-year low of 2500 mm. This basin straddles the 2500 mm rainfall contour and is generally in a slightly lower rainfall zone than Moses Inlet. The flow duration curves, representing percentages of time that various fractions of the mean annual flow are occurring on a monthly basis, have been calculated and are the basis of Figure 6.

3.2 FLOWS AVAILABLE FOR POWER GENERATION

In order to make the transition from the Sandell River flows and the Namu precipitation results there must be some correlation between the streamflow basins both geographically and hydrologically. The geographical correlation is provided by the relative proximity of the basins in terms of nearness to each other and to the ocean. They should be faced with similar monthly temperature ranges.

The hydrological correlation is suggested by several factors. As mentioned above, the basins both lie near the 2500 mm isohyet. An area-elevation plot, measuring the basin area contributing to flow below various elevation contours also indicates that the basins are similar. The Sandell River has 7.7% of its basin area as lake, while the combined lake and creek flow into Eberts Cove has 9.4% of the basin area as lake.

Analysis of winter flows at the Sandell River shows there is a strong correlation between precipitation, temperature and elevation. Basins of different elevation characteritics exhibit mean January flows proportional to the area below 750 m. At Moses Inlet, 75% of the basin area is below 750 m. As a consequence, the favourable winter flow pattern results in a slightly less favourable summer flow pattern. Most of the snow melt has run off by July, leaving August with reduced flows due to low rainfall and high evaporation. According to camp personnel the lake basin flows through the dry period, but the creek basin dries up. Calculations have been done to indicate the influence of the lake on natural and artificial flow regulation, as detailed below. The resulting basin parameters used for the design are as follows:

Mean Annual Runoff		= 2,500 mm
Basin Area	(Combined Lake and Creek) (Not including side slope below lake)	= 3.17 km^2
Mean Annual Flow		= 0.25 m^3/s
Firmness	(Expected Energy/Installed Capacity)	
	Design Flow = .20 m^3/s	= 76%
	.15 m^3/s	= 83%
	.10 m^3/s	= 90%

These parameters are based on Sandell River flows.

In addition it is estimated that the storage effect of the lake will improve low flows and allow more energy generation at all capacities. This effect, prorated for the difference in lake storage areas is shown on Figure 6 for natural lake regulation. The regulation achieved with a storage dam at the lake outlet has also been tested but is less economic.

The result of the various hydrological calculations leads to an assessment of the energy available from the creek system under different conditions. These are indicated on Table 3.1 on a monthly and annual basis. The expected use of the power is described in Section 4 and a graphical description of the energy available is shown in Figure 6.

TABLE 3.1

ENERGY AVAILABILITY

(Full camp with Energy Management, 90 kW Plant, Lake Flow only, 105 m head)

FLOW=	.30	.27	.42	.42	.84	.53	.27	.12	.16	.36	.55	.42
.95	.40	.42	.52	.54	1.01	.80	.39	.17	.22	.56	.66	.56
	.54	.56	.63	.66	1.11	.88	.48	.20	.28	.84	.79	.72
CAPACITY=	.62	.66	.74	.83	1.19	.97	.57	.25	.39	1.05	.98	.90
90.00	.72	.78	.86	1.02	1.28	1.08	.69	.31	.53	1.29	1.21	1.10
	.84	.93	1.03	1.20	1.37	1.28	.81	.42	.66	1.55	1.49	1.51
FLOW	1.05	1.17	1.22	1.34	1.48	1.36	.97	.54	.85	1.87	1.78	1.92
DURATION	1.36	1.48	1.43	1.46	1.57	1.60	1.16	.74	1.07	2.18	2.02	2.49
REGUL.	1.81	1.74	1.55	1.49	1.63	1.84	1.30	1.00	1.18	2.28	2.21	3.10
	2.01	1.52	1.35	1.31	1.47	1.83	1.29	1.07	.93	1.63	1.98	2.58
	.30	.27	.42	.42	.84	.53	.27	.12	.16	.36	.55	.42
	.40	.42	.52	.54	.95	.80	.39	.17	.22	.56	.66	.56
ENERGY	.54	.56	.63	.66	.95	.88	.48	.20	.28	.84	.79	.72
HISTOGRAM	.62	.66	.74	.83	.95	.95	.57	.25	.39	.95	.95	.90
	.72	.78	.86	.95	.95	.95	.69	.31	.53	.95	.95	.95
	.84	.93	.95	.95	.95	.95	.81	.42	.66	.95	.95	.95
	.95	.95	.95	.95	.95	.95	.95	.54	.85	.95	.95	.95
	.95	.95	.95	.95	.95	.95	.95	.74	.95	.95	.95	.95
	.95	.95	.95	.95	.95	.95	.95	.95	.95	.95	.95	.95
	.95	.95	.95	.95	.95	.95	.95	.95	.93	.95	.95	.95

DEMAND=	43858.80	34462.40	79511.94	69627.04	61835.94	50907.04	48635.94	38368.54	50867.04	65083.94	74427.04	39146.80
									TOTAL DEMAND=			655044.48
AVAILABLE ENERGY=	50889.60	47238.06	55823.49	55591.58	66184.67	60434.53	49409.43	32775.16	48388.63	59277.22	59002.11	58501.89
	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
									TOTAL AVAILABLE ENERGY=			635588
ENERGY 1	3.45	3.21	4.75	4.89	5.40	4.47	3.49	2.20	3.09	4.73	5.19	3.35
IN 2	1.14	1.03	1.58	1.63	1.88	1.66	1.27	.77	1.14	1.68	1.73	1.12
EACH 3	4.21	3.63	6.34	5.98	5.27	4.41	4.01	2.60	3.54	5.83	6.92	4.02
INTER- 4	1.15	1.04	1.58	1.63	1.85	1.58	1.22	.75	1.10	1.68	1.73	1.14
VAL 5	2.28	2.05	3.17	3.26	3.76	3.54	2.73	1.62	2.37	3.36	3.46	2.24
6	1.15	1.07	1.58	1.63	1.80	1.49	1.16	.73	1.03	1.58	1.73	1.12

EXPECTED ENERGY=	39320.27	31904.79	55823.49	54063.35	58605.70	48751.43	48751.75	25458.12	34835.83	55401.75	59002.11	38111.99
	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
										TOTAL ENERGY=		542022.58
										FIRMNESS=		88.61
DIESEL CAPACITY=		100.00								LOAD FACTOR=		68.75

4. POWER REQUIREMENTS

4.1 INSTALLED LOADS

The Moses Inlet camp is designed as "all-electric" with the exception of the cooking facilities. This is fortunate in terms of energy management at the camp because the potential loads caused by stoves and ovens is very high (30% - 50% of the camp installed capacity) but the amount of total energy used may be only 10% of the camp total. Propane used for cooking is also relatively inexpensive because it is utilized at nearly 100% burning efficiency. The notable factor in the load distribution at Moses Inlet is the predominance of space and water heat loads. As indicated on Table 4.1, the total space heat load is 184.5 kilowatts while the total water heat load is 189 kilowatts, which together comprise about 75% of the total installed camp load. These loads would vary with the season of the year and with the number of men in the camp.

The other potential area of activity at the camp is the workshop. A vehicle maintenance facility may be constructed just south of the main camp. Designs are not finalized, but it is expected that a workshop would contain lights, a compressor and miscellaneous power driven tools. Welders would likely be engine driven for portable use and thus would not affect the shop load. A small water heater would be needed for the washroom. It is expected that during the hours of operation, a maintenance facility would have a relatively low base load, with intermittent, unpredictable peaks caused by machinery use.

4.2 UNREGULATED POWER DEMANDS

In the existing mode of operation at Moses Inlet there is no attempt made to manage the loads. So far the single 100 kW diesel generator has been able to supply the demand. However the camp has not yet been fully occupied and future electrical demand could severely overload the generator unless some precautions are taken to regulate the demand.

The worst case of electrical demand would occur if the camp suffered a prolonged power outage (say for example during diesel engine repairs, or main circuit repairs). During the outage the building and the water heaters will all cool down simultaneously, so that when power is restored there will be an instantaneous demand as all the space and water heaters come on to reach their thermostat set points. Care will always need to be taken during the situation to gradually re-heat the building and hot water systems, one section at a time.

The regulated activities of the logging camp mean that many of the loads can be predicted to some extent. The typical day would see breakfast at 0630, which would require some load on the hot water and lighting systems. Subsequently, most of the crew would be out of the camp for the whole day. The cooking staff would remain preparing the evening meal. High loads may be expected during the day from the maintenance facility. It is the evening when loads could be the highest, especially in the spring and fall when extra heating and lighting loads would be present. Upon returning to camp at about 4:00 p m the crews would change and shower. Some men would then use the laundry while others could go to their rooms, using lights and heat, or to the TV lounge.

TABLE 4.1

MOSES INLET
SUMMARY OF ELECTRIC LOADS

		Kilowatts
Room and Lounge Baseboards		137.5
Room Water Heaters	9 x 12 kW (100 gal)	108
Laundry Water	3 x 12 kW (100 gal)	36
Kitchen Water	9 x 5 kW (100 gal)	45
Dining Room Furnace /Air Conditioner		47
Dryers	8 x 5400 Watts	44
Freezer	230 V 5.4 RLA 33.5 LRA	8
Fluorescent Lights		7
Incandescent Lights		31
Ventilation Fans (35)		
Laundry and Dry Fans (4)		
Kitchen Fans (3 large)		
Washing Machines		
Televisions, Light Appliances		
Kitchen Mixers, Toasters		
Machine Shop (information not available, facility not designed)		

In the meantime dinner is being prepared. After dinner (5:30 - 6:00 p m) there would be further use of the laundry, individual rooms and the common areas. All of the preceding activities could influence the electrical demand of the camp, especially those activities requiring hot water and heat. An example of the probable load pattern is shown in Table 4.2 (with energy management) and Table 4.3 (without energy management).

4.3 POWER DEMANDS WITH ENERGY MANAGEMENT

Energy management is a term used to describe the activities which both limit the total energy use and trim the peak loads at a power facility. At Moses Inlet, there is a need for energy management, but any activities in energy management must be tempered with the recognition that the purpose of the camp is to produce forest products efficiently and provide a comfortable environment for the work force in a rugged location. Therefore energy managment must not have a detrimental effect on productivity or on the comfort of the work force.

Despite the above restrictions, there are a number of ways in which the camp could manage energy. Considering the age and standard of construction of the camp there is probably little that can be done to minimize the total energy use. Assuming normal good conservation practices are followed, that thermostats are not set too high, and that energy is not wasted there is little that can be done to lower the total energy use. One of the most effective steps is to isolate areas of the camp which are not in use and reduce space and water heater set points to a minimum. Lights can also be controlled by reducing the intensity of lighting in common areas and turning off these lights when not in use.

The most significant steps in energy management could be made by balancing the potential peak loads, thereby reducing the need for additional generating capacity. This will have the effect of taking peak load energy and distributing it throughout the day, thereby increasing the load factor on the generating equipment. Though little can be saved in terms of total energy use it is always more efficient to increase the load factors on the generation equipment. Some examples of improved operating procedures include:

- increasing hot water storage, thereby allowing lower wattage elements to be used;
- scheduling laundry periods to avoid conflicts with other high energy use activities;
- preheating water in off-peak times or using generator waste heat to heat water;
- maintaining steady camp room temperatures to avoid numerous heaters coming on at once.

The simplest form of reducing peak loads is to install low wattage elements in the water heaters which will operate at near continuous output throughout the day. They will be effective because the major users of water (laundry and showers) are on separate systems and there is sufficient water storage to last for the once daily requirement for water. The set points for the sleeping room water heaters may need to be set higher to ensure that there is sufficient water through the peak shower demand. The comparison between load patterns of the "energy management" and "without energy management" cases is shown in Tables 4.2 and 4.3 respectively.

4.4 OPERATION OF THE EXISTING DIESEL PLANT

The existing diesel plant is temporarily located just north of the electrical control room and adjacent to the staff lounge. It consists of 2 - 100 kW diesel generators, load sharing apparatus and related controls housed in a plywood powerhouse. Crown Forest plans to relocate the plant in the near future and will probably coordinate the location with the hydro power plant.

The generator is maintained by a camp mechanic when the camp is in operation and by the caretaker during the winter. Routine maintenance consists of a daily recording of running time and kilowatts, occasional recording of fuel use, alternating the machines and changing filters. Minor repairs during camp operation are attempted by the mechanic but major repairs or work during the winter would require a mechanic to be flown in.

The annual fuel and maintenance costs are shown in Table 2.1.

TABLE 4.2

LOAD PATTERN WITH ENERGY MANAGEMENT - FULL CAMP

JANUARY CREW = 0

TIME	HEAT	WATER	LAUNDRY	DRYERS	FL. LT.	INCAN. CON	INCAN. IND	FREEZER	FANS	MISC.	CAMP TOTAL
M-6	56.00	.50	.00	.00	4.00	.00	.00	1.00	.00	.00	62
6-8	49.00	.50	.00	.00	7.00	3.00	.10	1.00	.00	.00	61
8-16	42.00	.50	.00	.00	7.00	3.00	.00	1.00	.00	1.00	55
16-18	49.00	.50	.00	.00	7.00	3.00	.10	1.00	.00	1.00	62
18-22	49.00	.50	.00	.00	7.00	3.00	.10	1.00	.00	.00	61
22-M	56.00	.50	.00	.00	4.00	.00	.00	1.00	.00	.00	62

FEBRUARY CREW = 0

TIME	HEAT	WATER	LAUNDRY	DRYERS	FL. LT.	INCAN. CON	INCAN. IND	FREEZER	FANS	MISC.	CAMP TOTAL
M-6	50.00	.50	.00	.00	4.00	.00	.00	1.00	.00	.00	56
6-8	41.00	.50	.00	.00	7.00	3.00	.10	1.00	.00	.00	53
8-16	33.00	.50	.00	.00	7.00	3.00	.00	1.00	.00	1.00	46
16-18	41.00	.50	.00	.00	7.00	3.00	.10	1.00	.00	1.00	54
18-22	41.00	.50	.00	.00	7.00	3.00	.10	1.00	.00	.00	53
22-M	50.00	.50	.00	.00	4.00	.00	.00	1.00	.00	.00	56

MARCH CREW = 70.00

TIME	HEAT	WATER	LAUNDRY	DRYERS	FL. LT.	INCAN. CON	INCAN. IND	FREEZER	FANS	MISC.	CAMP TOTAL
M-6	62.50	18.04	3.94	.00	4.00	5.00	4.93	4.00	1.00	1.97	105
6-8	51.00	18.04	3.94	.00	7.00	9.00	18.73	4.00	2.00	4.93	119
8-16	40.00	18.04	3.94	.00	7.00	11.50	1.97	4.00	1.00	4.93	92
16-18	51.00	18.04	3.94	.00	7.00	9.00	13.80	4.00	2.00	4.93	114
18-22	51.00	18.04	3.94	15.77	7.00	9.00	13.80	4.00	2.00	4.93	129
22-M	62.50	18.04	3.94	.00	4.00	5.00	4.93	4.00	1.00	1.97	105

APRIL CREW= 70.00

TIME	HEAT	WATER	LAUNDRY	DRYERS	FL. LT.	INCAN. CON	INCAN. IND	FREEZER	FANS	MISC.	CAMP TOTAL
M-6	55.00	18.04	3.94	.00	4.00	5.00	4.93	4.00	1.00	1.97	98
6-8	41.00	18.04	3.94	.00	7.00	9.00	18.73	4.00	2.00	4.93	109
8-16	27.00	18.04	3.94	.00	7.00	11.50	1.97	4.00	1.00	4.93	79
16-18	41.00	18.04	3.94	.00	7.00	9.00	13.80	4.00	2.00	4.93	104
18-22	41.00	18.04	3.94	15.77	7.00	9.00	13.80	4.00	2.00	4.93	119
22-M	55.00	18.04	3.94	.00	4.00	5.00	4.93	4.00	1.00	1.97	98

MAY CREW= 70.00

TIME	HEAT	WATER	LAUNDRY	DRYERS	FL. LT.	INCAN. CON	INCAN. IND	FREEZER	FANS	MISC.	CAMP TOTAL
M-6	43.00	18.04	3.94	.00	4.00	5.00	4.93	4.00	1.00	1.97	86
6-8	26.00	18.04	3.94	.00	7.00	9.00	18.73	4.00	2.00	4.93	94
8-16	10.00	18.04	3.94	.00	7.00	11.50	1.97	4.00	1.00	4.93	62
16-18	26.00	18.04	3.94	.00	7.00	9.00	13.80	4.00	2.00	4.93	89
18-22	26.00	18.04	3.94	15.77	7.00	9.00	13.80	4.00	2.00	4.93	104
22-M	43.00	18.04	3.94	.00	4.00	5.00	4.93	4.00	1.00	1.97	86

JUNE CREW= 70.00

TIME	HEAT	WATER	LAUNDRY	DRYERS	FL. LT.	INCAN. CON	INCAN. IND	FREEZER	FANS	MISC.	CAMP TOTAL
M-6	38.00	18.04	3.94	.00	4.00	5.00	4.93	4.00	1.00	1.97	73
6-8	15.00	18.04	3.94	.00	7.00	9.00	18.73	4.00	2.00	4.93	83
8-16	.00	18.04	3.94	.00	7.00	11.50	1.97	4.00	1.00	4.93	52
16-18	15.00	18.04	3.94	.00	7.00	9.00	13.80	4.00	2.00	4.93	78
18-22	15.00	18.04	3.94	15.77	7.00	9.00	13.80	4.00	2.00	4.93	93
22-M	38.00	18.04	3.94	.00	4.00	5.00	4.93	4.00	1.00	1.97	73

TABLE 4.2
LOAD PATTERN WITH ENERGY MANAGEMENT - FULL CAMP

JULY CREW= 70.00

TIME	HEAT	WATER	LAUNDRY	DRYERS	FL. LT.	INCAN.COM	INCAN.IND	FREEZER	FANS	MISC.	CAMP TOTAL
M-6	22.00	18.04	3.94	.00	4.00	5.00	4.93	4.00	1.00	1.97	65
6-8	7.00	18.04	3.94	.00	7.00	9.00	18.73	4.00	2.00	4.93	75
8-16	.00	18.04	3.94	.00	7.00	11.50	1.97	4.00	1.00	4.93	52
16-18	7.00	18.04	3.94	.00	7.00	9.00	13.80	4.00	2.00	4.93	70
18-22	7.00	18.04	3.94	15.77	7.00	9.00	13.80	4.00	2.00	4.93	85
22-M	22.00	18.04	3.94	.00	4.00	5.00	4.93	4.00	1.00	1.97	65

AUGUST CREW= 45.00

TIME	HEAT	WATER	LAUNDRY	DRYERS	FL. LT.	INCAN.COM	INCAN.IND	FREEZER	FANS	MISC.	CAMP TOTAL
M-6	20.00	11.60	2.54	.00	4.00	5.00	3.17	4.00	1.00	1.27	53
6-8	6.00	11.60	2.54	.00	7.00	9.00	12.04	4.00	2.00	3.17	57
8-16	.00	11.60	2.54	.00	7.00	11.50	1.27	4.00	1.00	3.17	42
16-18	6.00	11.60	2.54	.00	7.00	9.00	8.87	4.00	2.00	3.17	54
18-22	6.00	11.60	2.54	10.14	7.00	9.00	8.87	4.00	2.00	3.17	64
22-M	20.00	11.60	2.54	.00	4.00	5.00	3.17	4.00	1.00	1.27	53

SEPTEMBER CREW= 70.00

TIME	HEAT	WATER	LAUNDRY	DRYERS	FL. LT.	INCAN.COM	INCAN.IND	FREEZER	FANS	MISC.	CAMP TOTAL
M-6	26.00	18.04	3.94	.00	4.00	5.00	4.93	4.00	1.00	1.97	69
6-8	14.00	18.04	3.94	.00	7.00	9.00	18.73	4.00	2.00	4.93	82
8-16	1.50	18.04	3.94	.00	7.00	11.50	1.97	4.00	1.00	4.93	54
16-18	14.00	18.04	3.94	.00	7.00	9.00	13.80	4.00	2.00	4.93	77
18-22	14.00	18.04	3.94	15.77	7.00	9.00	13.80	4.00	2.00	4.93	92
22-M	26.00	18.04	3.94	.00	4.00	5.00	4.93	4.00	1.00	1.97	69

OCTOBER CREW= 70.00

TIME	HEAT	WATER	LAUNDRY	DRYERS	FL. LT.	INCAN.COM	INCAN.IND	FREEZER	FANS	MISC.	CAMP TOTAL
M-6	40.00	18.04	3.94	.00	4.00	5.00	4.93	4.00	1.00	1.97	83
6-8	32.00	18.04	3.94	.00	7.00	9.00	18.73	4.00	2.00	4.93	100
8-16	23.00	18.04	3.94	.00	7.00	11.50	1.97	4.00	1.00	4.93	75
16-18	32.00	18.04	3.94	.00	7.00	9.00	13.80	4.00	2.00	4.93	95
18-22	32.00	18.04	3.94	15.77	7.00	9.00	13.80	4.00	2.00	4.93	110
22-M	40.00	18.04	3.94	.00	4.00	5.00	4.93	4.00	1.00	1.97	83

NOVEMBER CREW= 70.00

TIME	HEAT	WATER	LAUNDRY	DRYERS	FL. LT.	INCAN.COM	INCAN.IND	FREEZER	FANS	MISC.	CAMP TOTAL
M-6	55.00	18.04	3.94	.00	4.00	5.00	4.93	4.00	1.00	1.97	98
6-8	48.00	18.04	3.94	.00	7.00	9.00	18.73	4.00	2.00	4.93	116
8-16	40.00	18.04	3.94	.00	7.00	11.50	1.97	4.00	1.00	4.93	92
16-18	48.00	18.04	3.94	.00	7.00	9.00	13.80	4.00	2.00	4.93	111
18-22	48.00	18.04	3.94	15.77	7.00	9.00	13.80	4.00	2.00	4.93	126
22-M	55.00	18.04	3.94	.00	4.00	5.00	4.93	4.00	1.00	1.97	98

DECEMBER CREW= 0

TIME	HEAT	WATER	LAUNDRY	DRYERS	FL. LT.	INCAN.COM	INCAN.IND	FREEZER	FANS	MISC.	CAMP TOTAL
M-6	49.00	.50	.00	.00	4.00	.00	.00	1.00	.00	.00	55
6-8	43.00	.50	.00	.00	7.00	3.00	.10	1.00	.00	.00	55
8-16	36.00	.50	.00	.00	7.00	3.00	.00	1.00	.00	1.00	49
16-18	43.00	.50	.00	.00	7.00	3.00	.10	1.00	.00	1.00	56
18-22	43.00	.50	.00	.00	7.00	3.00	.10	1.00	.00	.00	55
22-M	43.00	.50	.00	.00	4.00	.00	.00	1.00	.00	.00	55

TABLE 4.3

LOAD PATTERN WITHOUT ENERGY MANAGEMENT - FULL CAMP

JANUARY CREW = 0

TIME	HEAT	WATER	LAUNDRY	DRYERS	FL. LT.	INCAN. COM	INCAN. IND	FREEZER	FANS	MISC.	CAMP TOTAL
M-6	56.00	.50	.00	.00	4.00	.00	.00	1.00	.00	.00	62
6-8	49.00	.50	.00	.00	7.00	3.00	.10	1.00	.00	.00	61
8-16	42.00	.50	.00	.00	7.00	3.00	.00	1.00	.00	1.00	55
16-18	49.00	.50	.00	.00	7.00	3.00	.10	1.00	.00	1.00	62
18-22	49.00	.50	.00	.00	7.00	3.00	.10	1.00	.00	.00	61
22-M	56.00	.50	.00	.00	4.00	.00	.00	1.00	.00	.00	62

FEBRUARY CREW = 0

TIME	HEAT	WATER	LAUNDRY	DRYERS	FL. LT.	INCAN. COM	INCAN. IND	FREEZER	FANS	MISC.	CAMP TOTAL
M-6	50.00	.50	.00	.00	4.00	.00	.00	1.00	.00	.00	56
6-8	41.00	.50	.00	.00	7.00	3.00	.10	1.00	.00	.00	53
8-16	33.00	.50	.00	.00	7.00	3.00	.00	1.00	.00	1.00	46
16-18	41.00	.50	.00	.00	7.00	3.00	.10	1.00	.00	1.00	54
18-22	41.00	.50	.00	.00	7.00	3.00	.10	1.00	.00	.00	53
22-M	50.00	.50	.00	.00	4.00	.00	.00	1.00	.00	.00	56

MARCH CREW = 70.00

TIME	HEAT	WATER	LAUNDRY	DRYERS	FL. LT.	INCAN. COM	INCAN. IND	FREEZER	FANS	MISC.	CAMP TOTAL
M-6	62.50	.00	.00	.00	4.00	5.00	4.93	4.00	1.00	1.97	83
6-8	51.00	9.86	.00	.00	7.00	9.00	18.73	4.00	2.00	4.93	107
8-16	40.00	4.93	.00	.00	7.00	11.50	1.97	4.00	1.00	4.93	75
16-18	51.00	106.48	.00	.00	7.00	9.00	13.80	4.00	2.00	4.93	198
18-22	51.00	36.48	20.70	15.77	7.00	9.00	13.80	4.00	2.00	4.93	165
22-M	62.50	.00	.00	.00	4.00	5.00	4.93	4.00	1.00	1.97	83

APRIL CREW= 70.00

TIME	HEAT	WATER	LAUNDRY	DRYERS	FL. LT.	INCAN. COM	INCAN. IND	FREEZER	FANS	MISC.	CAMP TOTAL
M-6	55.00	.00	.00	.00	4.00	5.00	4.93	4.00	1.00	1.97	76
6-8	41.00	9.86	.00	.00	7.00	9.00	18.73	4.00	2.00	4.93	97
8-16	27.00	4.93	.00	.00	7.00	11.50	1.97	4.00	1.00	4.93	62
16-18	41.00	106.48	.00	.00	7.00	9.00	13.80	4.00	2.00	4.93	188
18-22	41.00	36.48	20.70	15.77	7.00	9.00	13.80	4.00	2.00	4.93	155
22-M	55.00	.00	.00	.00	4.00	5.00	4.93	4.00	1.00	1.97	76

MAY CREW= 70.00

TIME	HEAT	WATER	LAUNDRY	DRYERS	FL. LT.	INCAN. COM	INCAN. IND	FREEZER	FANS	MISC.	CAMP TOTAL
M-6	43.00	.00	.00	.00	4.00	5.00	4.93	4.00	1.00	1.97	64
6-8	26.00	9.86	.00	.00	7.00	9.00	18.73	4.00	2.00	4.93	82
8-16	10.00	4.93	.00	.00	7.00	11.50	1.97	4.00	1.00	4.93	45
16-18	26.00	106.48	.00	.00	7.00	9.00	13.80	4.00	2.00	4.93	173
18-22	26.00	36.48	20.70	15.77	7.00	9.00	13.80	4.00	2.00	4.93	140
22-M	43.00	.00	.00	.00	4.00	5.00	4.93	4.00	1.00	1.97	64

JUNE CREW= 70.00

TIME	HEAT	WATER	LAUNDRY	DRYERS	FL. LT.	INCAN. COM	INCAN. IND	FREEZER	FANS	MISC.	CAMP TOTAL
M-6	30.00	.00	.00	.00	4.00	5.00	4.93	4.00	1.00	1.97	51
6-8	15.00	9.86	.00	.00	7.00	9.00	18.73	4.00	2.00	4.93	71
8-16	.00	4.93	.00	.00	7.00	11.50	1.97	4.00	1.00	4.93	35
16-18	15.00	106.48	.00	.00	7.00	9.00	13.80	4.00	2.00	4.93	162
18-22	15.00	36.48	20.70	15.77	7.00	9.00	13.80	4.00	2.00	4.93	129
22-M	32.00	.00	.00	.00	4.00	5.00	4.93	4.00	1.00	1.97	51

TABLE 4. 3

LOAD PATTERN WITHOUT ENERGY MANAGEMENT - FULL CAMP

JULY CREW= 70.00

TIME	HEAT	WATER	LAUNDRY	DRYERS	FL. LT.	INCAN.COM	INCAN.IND	FREEZER	FANS	MISC.	CAMP TOTAL
M-6	22.00	.00	.00	.00	4.00	5.00	4.93	4.00	1.00	1.97	43
6-8	7.00	9.86	.00	.00	7.00	9.00	18.73	4.00	2.00	4.93	63
8-16	.00	4.93	.00	.00	7.00	11.50	1.97	4.00	1.00	4.93	35
16-18	7.00	106.48	.00	.00	7.00	9.00	13.80	4.00	2.00	4.93	154
18-22	7.00	36.48	20.70	15.77	7.00	9.00	13.80	4.00	2.00	4.93	121
22-M	22.00	.00	.00	.00	4.00	5.00	4.93	4.00	1.00	1.97	43

AUGUST CREW= 45.00

TIME	HEAT	WATER	LAUNDRY	DRYERS	FL. LT.	INCAN.COM	INCAN.IND	FREEZER	FANS	MISC.	CAMP TOTAL
M-6	20.00	.00	.00	.00	4.00	5.00	3.17	4.00	1.00	1.27	38
6-8	6.00	6.34	.00	.00	7.00	9.00	12.04	4.00	2.00	3.17	50
8-16	.00	3.17	.00	.00	7.00	11.50	1.27	4.00	1.00	3.17	31
16-18	6.00	68.45	.00	.00	7.00	9.00	8.87	4.00	2.00	3.17	108
18-22	6.00	23.45	13.31	10.14	7.00	9.00	8.87	4.00	2.00	3.17	87
22-M	20.00	.00	.00	.00	4.00	5.00	3.17	4.00	1.00	1.27	38

SEPTEMBER CREW= 70.00

TIME	HEAT	WATER	LAUNDRY	DRYERS	FL. LT.	INCAN.COM	INCAN.IND	FREEZER	FANS	MISC.	CAMP TOTAL
M-6	26.00	.00	.00	.00	4.00	5.00	4.93	4.00	1.00	1.97	47
6-8	14.00	9.86	.00	.00	7.00	9.00	18.73	4.00	2.00	4.93	70
8-16	1.50	4.93	.00	.00	7.00	11.50	1.97	4.00	1.00	4.93	37
16-18	14.00	106.48	.00	.00	7.00	9.00	13.80	4.00	2.00	4.93	161
18-22	14.00	36.48	20.70	15.77	7.00	9.00	13.80	4.00	2.00	4.93	128
22-M	26.00	.00	.00	.00	4.00	5.00	4.93	4.00	1.00	1.97	47

OCTOBER CREW= 70.00

TIME	HEAT	WATER	LAUNDRY	DRYERS	FL. LT.	INCAN.COM	INCAN.IND	FREEZER	FANS	MISC.	CAMP TOTAL
M-6	40.00	.00	.00	.00	4.00	5.00	4.93	4.00	1.00	1.97	61
6-8	32.00	9.86	.00	.00	7.00	9.00	18.73	4.00	2.00	4.93	88
8-16	23.00	4.93	.00	.00	7.00	11.50	1.97	4.00	1.00	4.93	58
16-18	32.00	106.48	.00	.00	7.00	9.00	13.80	4.00	2.00	4.93	179
18-22	32.00	36.48	20.70	15.77	7.00	9.00	13.80	4.00	2.00	4.93	146
22-M	40.00	.00	.00	.00	4.00	5.00	4.93	4.00	1.00	1.97	61

NOVEMBER CREW= 70.00

TIME	HEAT	WATER	LAUNDRY	DRYERS	FL. LT.	INCAN.COM	INCAN.IND	FREEZER	FANS	MISC.	CAMP TOTAL
M-6	55.00	.00	.00	.00	4.00	5.00	4.93	4.00	1.00	1.97	76
6-8	48.00	9.86	.00	.00	7.00	9.00	18.73	4.00	2.00	4.93	104
8-16	48.00	4.93	.00	.00	7.00	11.50	1.97	4.00	1.00	4.93	75
16-18	48.00	106.48	.00	.00	7.00	9.00	13.80	4.00	2.00	4.93	195
18-22	48.00	36.48	20.70	15.77	7.00	9.00	13.80	4.00	2.00	4.93	162
22-M	55.00	.00	.00	.00	4.00	5.00	4.93	4.00	1.00	1.97	76

DECEMBER CREW= 0

TIME	HEAT	WATER	LAUNDRY	DRYERS	FL. LT.	INCAN.COM	INCAN.IND	FREEZER	FANS	MISC.	CAMP TOTAL
M-6	49.00	.50	.00	.00	4.00	.00	.00	1.00	.00	.00	55
6-8	43.00	.50	.00	.00	7.00	3.00	.10	1.00	.00	.00	55
8-16	36.00	.50	.00	.00	7.00	3.00	.00	1.00	.00	1.00	49
16-18	43.00	.50	.00	.00	7.00	3.00	.10	1.00	.00	1.00	56
18-22	43.00	.50	.00	.00	7.00	3.00	.10	1.00	.00	.00	55
22-M	49.00	.50	.00	.00	4.00	.00	.00	1.00	.00	.00	55

5. PROJECT LAYOUT AND DESIGN

5.1 PROJECT SIZE

The sizing of the Moses Inlet Hydro Power Plant must consider the loads on the system as well as the available power in the stream. Of prime importance is the fact that with hydro power, most of the costs are fixed hence it is advantageous to run the plant as close to full load as possible, thereby reducing overall cost per kilowatt-hour.

At Moses Inlet, the project size is partly determined by the geography (head), hydrology (flow) and the availability of penstock sizes. Penstocks come in discrete increments of 50 mm size variations, hence there are considerable variations in the flow each size will pass. It has also been proven in previous studies that it is advantageous to design the power system to the full capacity of the penstock. However the penstock can be built using combinations of two pipe sizes to suit intermediate ranges.

In actual fact there are infinitely many power system sizes to chose from, ranging from the minimum system demand (base load) to the maximum (peak load). This would mean that in order to achieve the most cost effective plant size, all variables should be designed and costed against the load demand.

Normally this procedure is not done because certain design parameters are already well established by site conditions and the sensitivity of design variations can be tested in discrete increments. What follows is the minimum size project design which is considered to be technically and economically feasible, but which can be altered based on a consideration of costs and risks as detailed in Section 5.5.

5.2 PROJECT LAYOUT

The project layout for the Moses Inlet Hydro Power Plant is relatively simple. It is designed to minimize construction problems while also minimizing material usage.

The powerhouse would be set just above the high tide mark adjacent to the main road near the dock. This would be fed by the penstock (buried in the road) which would pass from the intake along the side of the creek, through the riprap, past the maintenance facility, then the camp and finally to the powerhouse.

This layout maximizes power output while making the construction of the penstock (as a buried pipe) as simple as possible. The only significant variable in the design is the location of the intake. There is some flexibility here, although few good intake locations exist. The lowest intake site which was acceptable was at the 105 m level. The highest an intake can go on this section of creek is about 140 m, which just allows the lake outflow to be included. A diversion from the south fork of the creek at about the 145 m level effectively doubles the stream drainage area as it directs the stream flow into the main intake area.

The layout also makes the project convenient to maintain. The powerhouse is close to the road and the ocean, as well as being close to the main camp, all of which contribute to ease of maintenance. The intake would be accessible by vehicle and on foot, and it would have both manual and automatic cleaning features.

5.3 DESIGN OF COMPONENTS - CIVIL

Intake: The intake requires the most artistry of any of the components. It must blend into uneven terrain and achieve the objectives of sediment separation, freeze protection, and favourable hydraulic entrance conditions. The exact configuration of the intake depends largely on the local stream bed conditions. At Moses Inlet the main intake would be on bedrock or large boulders. It would at times need to take the entire stream flow while at other times it would pass flow over the top. A debris guard would be provided as well as a mainline valve, air vent and sediment drain. The typical details are shown on Figure 7.

There may also be an upper intake on this project to divert water from the south creek fork to the main channel. This intake would again take all of the flow in the channel at most times, but the intake would be simpler. Flow would be by gravity to the main intake area, so valves would be eliminated and the collected sediment would be separated at the main intake. It could be compared to a culvert inlet and the pipe would be laid on the surface following a contour.

Penstock: The penstock design involves choices of pipe size, materials and construction methods. At Moses Inlet the main considerations are the pressure rating of the pipe and whether it be constructed above or below ground.

In terms of pressure rating, the maximum static pressure on the penstock could be 190 psi (1330 KPa). This is within the range of both polyethylene and PVC plastic pipes. The preferred method of construction would be to bury a PVC pipe, beginning at a low pressure rating near the intake and progressing to the higher ratings near the powerhouse. Buried pipe is preferable because it needs less anchoring and it is protected from freezing, mechanical impact and weathering. In the case where an above ground pipe may be required, such as from the upper end of the riprap to the intake (depending on final ground conditions) an above ground polyethylene pipe would be preferred for its flexibility, relative light weight and ease of anchoring.

Several pipe sizes were evaluated in different types to determine the most favourable for the situation. In considering that more than 50 kW would be required and available, a 250 mm pipe was found to have a capacity of 88 kW to 120 kW depending on the intake elevation, while a 300 mm pipe would have a capacity of 140 kW to 185 kW. The evaluation in this study is carried out with 250 mm diameter pipe as a base size, with the extra cost of increasing size shown in increments as larger plant size options are evaluated.

Powerhouse: The powerhouse at Moses Inlet is designed with several criteria in mind. Some of the criteria are determined by the location (on gravelly soil adjacent to a road) while others are determined by the situation (a 20 year project for a nearby logging camp). Accordingly the powerhouse is designed to consider the relative ease of access and the lifespan of the camp.

The main components of the powerhouse are the inlet, the slab, the tailrace, the turbine, the electrical equipment and the building shell. The inlet provides the transition between the penstock and the turbine. There will be a terminal anchor block to withstand the end thrust on the pipe, and a transition to steel pipe from the PVC. There will be a shutoff valve, a slip coupling and possibly a reducer before the turbine inlet is reached. A small diameter drain will lead from the lowest part of the penstock.

The powerhouse slab must be a reinforced concrete structure, heavy enough to withstand the weight, thrust and vibration from the turbine. Its smooth upper surface will serve as the powerhouse floor. In order to minimize the amount of concrete used, consideration will be given to casting the slab integrally with the rock or soil sub-base, thus tying in the powerhouse to the ground. The footing walls serve to incorporate the subbase to the slab and effectively increase the mass of the structure at low cost.

The tailrace would be cast as part of the powerhouse slab. It carries the water discharge from the turbine to Eberts Cove. The concrete channel would be built far enough from the powerhouse to ensure that erosion of the foundation would not result, then a rock lined channel would carry the water.

The turbine is the central feature of the powerhouse. While every change of head and flow requires a different design for optimum performance, probably two types of turbine would cover the range required by Moses Inlet camp. At the lower end of the power range a 75 kW vertical shaft turgo impulse wheel could be provided. This unit would be mounted on the powerhouse floor and the generator would be mounted directly above the turbine. This arrangement ensures a unitized turbine/generator and conserves floor space. Alternatively a larger twin jet Pelton unit of up to 150 kW capacity could be installed using a combination of higher head and/or flow. This size of unit, although not appreciably larger than the first described may require a horizontal shaft and some additional powerhouse space. The electrical equipment is described in Section 5.4.

The powerhouse is intended to protect the generating equipment from the weather and allow for convenient servicing and adjustment. The additional design criteria at Moses Inlet are that there is a 20 year design life and the powerhouse is accessible to service vehicles. Therefore a wood frame building is proposed which would allow sufficient access for servicing with two double doors but which would be small overall, as the operator spends little time there. The interior would feature lights and heaters in addition to the electrical control panels, and provision would be made to feed power from the main system when the hydro plant was not operating.

5.4 DESIGN OF COMPONENTS - ELECTRICAL

Electrical design covers the specification of the generator, main breaker, system protection, powerhouse services and monitoring systems in the powerhouse, plus the load sharing and synchronization of the hydro plant into the existing diesel system. The primary concerns of the design are safety, delivery of power, protection of system components and optimization of power output from the hydro plant.

Despite their importance the first three design criteria are relatively standard items and would be handled routinely in the course of preliminary and final designs. This section deals with the more unconventional approach whereby the hydro power plant is sized to an optimum which is lower than the system demand.

There are several key components in the design of the Moses Inlet system. There must be synchronization and control of the power feed to the diesels (when they are running) as well as optimization of the power output from the hydro power plant. In addition, there must be a control on the intake water level which is subject to stream flow variations.

Fortunately, many of the mechanisms described above are either available at site now, purchased as off the shelf items or are design features of the normal control systems. The present diesel system can be paralleled (two diesels operating) using the existing No 2301 Load Share Module. When the hydro unit (assuming a 75 kW capacity) is operated in conjunction with the diesel(s) it can be set to take the base load simply by adjusting the speed droop on the respective governors. With a slow droop (70%) on the hydro unit and a fast droop (0%) on the diesels, the diesels will pick up the load swings and the hydro plant will stay stable at 75 kW. If there is insufficient flow for 75 kW, the head level control will pulse the speed adjusting water to drop load from the hydro unit which will in turn reduce flow in the penstock and stabilize the intake level.

When the camp loads are below 75 kW and assuming sufficient flow in the creek the hydro plant will be able to operate in isolation. The diesels are turned off and system frequency is maintained by the hydro plant governor set at 0% droop. The electrical design features are indicated in Figure 4.

5.5 DESIGN OPTIONS

There are a number of design options possible at Moses Inlet, including high head/high capacity schemes, lake level discharge structures, increased plant capacity, and the creek intake level control. There are numerous other options which occur during the course of design, but most of these are more obvious choices based on engineering judgment and they are not discussed in this section.

Capacity Layout

There are two principal choices of scheme layout: the low head scheme described in this report and the high head scheme. The high head scheme

features an intake at the 469 meter level at the outlet of the lake and a powerhouse where the steep hillside begins to level out near the camp. Because of the high head the energy lost by not going to sea level is inconsequential. This project would have a capacity of 250 kW and because of the lake storage it would be considered firm. The camp would only require diesels for standby power. However, many aspects of this scheme involve higher cost and risk, particularly the intake and penstock. Costs are high because of the difficult access and working conditions on the 30° hillside and the need for using a steel penstock to withstand the high water pressures. In addition, the load curve for the camp as indicated in Figure 5 has diminishing times when the high capacity is being used, hence the incremental cost of the excess energy is increasing. Preliminary cost estimates of this scheme indicated it was slightly higher in cost per kilowatt, and when the extra risk is accounted for, covering the uncertainties of hillside construction and access for maintenance, the scheme becomes less attractive than the low level project.

Lake Level Discharge Structure

A possible compromise between the high and low level schemes is to construct a control structure at the lake outlet to regulate the lake. Water from high rainfall periods would be released at a nearly steady rate to supplement low flows. The water would follow the same natural course it presently does from the lake to the low level intake area. The effect of the structure combined with unregulated and naturally regulated flows is shown on Figure 6. This indicates that up to 22,000 extra kW annually may be available from the outlet assuming the predicted camp load patterns. Preliminary cost estimates indicate that this proposal is about equal in cost with diesel generation considering the cost and the extra energy received. However, considering the risks involved in construction and operation and the magnitude of the power gain the extra work may not be justified at this time. In any event, because the intake is isolated from the main project it may be possible to defer construction of the control structure with little change in its eventual cost.

Increased Plant Capacity

The minimum plant size of 75 kW can be increased in two ways. Either the flow can be increased, in which case the penstock and turbine would be increased in size to accommodate the change or the head could be increased, in which case the penstock would be lengthened and the turbine size increased. A combination of both methods would yield a further increase in capacity. However, as indicated on Figure 5, Load Profile, the increases in capacity are not matched precisely by increases in load because higher loads are required for progressively less time.

Increasing the flow at the plant is a matter of increasing the intake equipment, the penstock and the turbine/generator. For a 75 kW plant with a 250 mm penstock (initially) the penstock would be increased to 300 mm diameter and the turbine to 115 kW reflecting the increased flow capacity of the penstock. The available energy would also increase, but its firmness would decrease from 90% to 82% reflecting the higher proportion of the mean annual flow being utilized.

Alternatively, the energy could be increased by lengthening the penstock to develop an intake at the 140 meter level. Here the power would go to about 100 kW at the same firmness of 90%.

Similarly, increasing both the flow and the head on the plant would result in a power availability of 150 kW at a firmness of 82%. The tabulations of these options are shown in Section 6.1 and their relative economics in Section 7.1.

Creek Intake Level Control

As described in Section 5.4 the creek intake level control can be used to allow continued operation of the plant despite low flows. With the flow patterns at Moses Inlet, low flows could be expected about 20% of the time. However, there is still considerable amounts of energy in these flows and the energy would be well used, as part of the base load of the camp. Preliminary estimates would predict a payback period on this device of about 6 months, hence it is considered an essential option.

6. PROJECT COST ESTIMATE

6.1 CONSTRUCTION COST

The construction cost of the Moses Inlet Hydro Power Plant is based on combinations of materials costs, installation costs, transportation costs and overheads. The transportation and overhead costs especially are adjusted to account for the uncertainties of working in an isolated location. The construction cost refers to the costs expended under contract between the authorization to proceed with work and the commissioning. The costs are summarized in Table 6.1 for a full range of sizes, but the load factors and resulting cost indices are based on an idealized power demand. The table indicates the economy of scale in increasing plant sizes (based on a cost per installed kilowatt) but also shows an increasing cost per kilowatt hour based on lack of demand.

Materials costs are dominated by products which must be shipped in to Moses Inlet. These include the turbine, generator and electrical equipment, the penstock pipe, cement, metal work, and building components. The only materials available locally would be aggregates for making concrete and penstock backfill, but because aggregates can amount to a large weight of material, it is a great advantage to have them on hand. The cost estimates shown are based on the raw material cost or the unit price of completed work as appropriate.

Labour costs on the project are composed of the times for skilled and unskilled labour to complete the installations. Most of the work force can be relatively unskilled, the only exceptions being superintendence, electrical work, and turbine/governor placement. Labour costs also are influenced by the costs of transportation time around the site and to Moses Inlet. The proposed project is close to the camp, so on site travel time can be kept to a minimum. Travel to Moses Inlet can be minimized by ensuring the workforce can adapt to the isolation, that the workers are versatile and that scheduling is continuous.

Equipment charges can be significant on a project of this nature, but not because of a heavy use of the equipment. Instead the equipment that is required must be used at several times throughout the job for relatively short periods of time. The equipment to be used would include a bulldozer and/or backhoe for access construction to the intake, backhoe for penstock trenching, a lift truck for equipment and penstock placement and a truck for transporting smaller tools and equipment. All of this equipment would normally be rented and charges would accrue from the date of shipment to the date of return. Significant savings would result if local equipment was hired on an hourly basis.

Overhead on the project results from the office expenses, accommodation costs and other fixed costs of the contractor. Overhead is generally a direct function of time, hence it can be reduced by ensuring that the project is built in as short a time as possible, consistent with not spending excessively in other areas of the job to achieve the time saving. Accommodation costs can be minimized by staying at the camp and only paying for the share of variable cost incurred by the camp owner.

TABLE 6.1
COSTS OF VARIOUS SIZE RANGES

[illegible]	HEAD	POWER	PENSTOCK	INTAKE	POWERHOUSE	ELECTRIC	ACCESS	UPPERINT	TURBINE	SUBTOTAL	ENG'NG	TOTAL	FLOWFRAC	LOADFACT	$INDEX
1.00	105.00	75.00	73440.00	20000.00	27000.00	41000.00	10000.00	12300.00	73000.00	256740.00	40000.00	314544.40	.43	.81	13.40
2.00	105.00	80.00	73440.00	20000.00	27405.00	41400.00	10000.00	12300.00	78000.00	262545.00	40000.00	320697.70	.46	.78	13.22
3.00	105.00	85.00	73440.00	20000.00	27810.00	41800.00	10000.00	12300.00	82000.00	267350.00	40000.00	325791.00	.49	.76	13.07
4.00	105.00	90.00	73440.00	20000.00	28215.00	42200.00	10000.00	12300.00	86000.00	272155.00	40000.00	330884.30	.52	.73	12.97
5.00	105.00	95.00	75170.00	23000.00	28620.00	42600.00	10000.00	12300.00	90000.00	281690.00	40000.00	340991.40	.54	.70	13.05
6.00	105.00	100.00	76900.00	23000.00	29025.00	43000.00	10000.00	12300.00	94000.00	288225.00	40000.00	347918.50	.58	.67	13.17
7.00	105.00	110.00	80360.00	23000.00	29430.00	44200.00	10000.00	12300.00	104000.00	303290.00	40000.00	363887.40	.63	.62	13.46
8.00	105.00	120.00	83820.00	23000.00	29835.00	45400.00	10000.00	12300.00	111000.00	315355.00	40000.00	376676.30	.69	.57	13.77
9.00	105.00	130.00	87280.00	23000.00	30240.00	46000.00	10000.00	12300.00	120000.00	328820.00	40000.00	390949.20	.75	.53	14.18
10.00	105.00	140.00	90740.00	23000.00	30645.00	46000.00	10000.00	12300.00	127000.00	339685.00	40000.00	402466.10	.79	.49	14.46
11.00	140.00	90.00	94340.00	20000.00	31320.00	42200.00	16000.00	12300.00	76000.00	292160.00	40000.00	352089.60	.39	.74	13.41
12.00	140.00	100.00	94340.00	20000.00	31860.00	43000.00	16000.00	12300.00	82000.00	299500.00	40000.00	359870.00	.43	.70	13.00
13.00	140.00	110.00	94340.00	20000.00	32400.00	44200.00	16000.00	12300.00	88000.00	307240.00	40000.00	368074.40	.48	.64	13.09
14.00	140.00	120.00	97311.20	20000.00	32670.00	45400.00	16000.00	12300.00	95000.00	318681.20	40000.00	380282.07	.52	.59	13.33
15.00	140.00	130.00	100282.40	23000.00	33210.00	46000.00	16000.00	12300.00	101000.00	331792.40	40000.00	394099.94	.56	.55	13.70
16.00	140.00	140.00	103253.60	23000.00	33750.00	46000.00	16000.00	12300.00	107000.00	341383.60	40000.00	404181.82	.60	.51	13.96
17.00	140.00	150.00	106224.80	23000.00	34155.00	46000.00	16000.00	12300.00	112000.00	349679.80	40000.00	413060.59	.63	.48	14.14
18.00	140.00	160.00	110186.40	23000.00	34560.00	47600.00	16000.00	12300.00	119000.00	362646.40	40000.00	426805.18	.69	.45	14.63
19.00	140.00	170.00	114148.00	23000.00	35100.00	49200.00	16000.00	12300.00	124000.00	373748.00	40000.00	438572.88	.74	.42	14.96
20.00	140.00	180.00	114148.00	23000.00	35370.00	51000.00	16000.00	12300.00	128000.00	379818.00	40000.00	445007.08	.78	.40	15.12

[illegible] 750 LONG=	73440.00	250mm INTAKE=	20000.00	ACCESS TO 105m=	10000.00	CAPITAL RECOVERY=	.18
[illegible] 750 LONG=	90740.00	300mm INTAKE=	23000.00	ACCESS TO 140m=	16000.00	MAINTENANCE = AND ADMIN.	16000.00
250 to 900 LONG=	94340.00	UPPER INTAKE=	12300.00				
300 to 900 LONG=	114148.00	POWERHOUSE=	27000.00	ENGINEERING=	40000.00	DEVEL.$=	1.06

A detailed cost breakdown of the cost of a 90 kilowatt plant at 105 meters of head is shown in Table 6.2.

6.2 DEVELOPMENT COST

The development costs of the project include those costs necessary to bring about the project but not directly related to the construction contract. These include the costs of the developer to administer all contracts with the equipment supplier, the construction contractor, the engineers and the camp operators who are purchasing the power. There is some continuing cost as the developer must monitor the generation of the plant and secure payments and pay for maintenance. The development costs are shown in Table 6.3.

The remaining engineering costs on the project include the final design, tender document preparation, site inspection and preparation of the operation and maintenance manual and commissioning of the plant. Some of these costs,particularly the site inspection cannot be determined until further information is available nearer the time of tendering. These costs are estimated in terms of the lump sum allowance on Table 6.1. The engineering supervision cost is based on a series of progress inspections at critical stages of the work rather than full time supervision. The engineering costs are described in Table 6.2.

6.3 OPERATING COST

The operating costs of a small hydro power plant are relatively low, especially compared with diesel generation, but they cannot be neglected. The most important aspects concern regular inspections and proper maintenance procedures.

The plant itself is designed for automatic operation. Once it is either paralleled with a diesel generator or set to run in isolation no further adjustment will be necessary. Maintenance will consist of recording meter readings, ensuring the intake is clean and providing lubrication at specified intervals. When the plant is switched from one operating mode to another (with or without diesel generation) the adjustments will be simple and rapid. Materials used would mainly consist of lubricants.

The next category of preventative maintenance is regular technical inspection. At intervals of 6 months to one year the plant should be thoroughly examined by a qualified technician to inspect the operation and the condition of critical components. This can forestall some repairs which may be required in future if a condition causing wear or damage is allowed to persist.

The final category of maintenance is the emergency repair. Usually this will be required after a harmful condition has initiated a shutdown of the turbine through its protection system. Numerous mechanical or electrical components can fail but the result of the failure will lead to an irregularity in one of the monitored systems which in turn will cause a shut down. The frequency of such events would be irregular and unpredictable, but some allowance has to be made for the cost of the repair in terms of labour, parts and lost revenue. This cost is also shown in Table 6.1 and detailed in Table 6.4.

TABLE 6.2
DETAILED COSTS FOR 90 KW PLANT AT 105 M HEAD

1. **PENSTOCK:** 250 mm Diameter, 758 m long

1.1	**Pipe Supply**		
	381 m Series 100 @ $25.48	$ 9,707.88	$
	377 m Series 160 @ 39.50	14,891.50	
	3% Spare	740.00	
		25,337.36	
	7% PST	1,773.60	27,200.00
1.2	**Delivery on Coast Ferries**		
	128 lengths @ 16.6 ft^3 @ 7.15/2ft^3 = 7626.66		7,700.00
1.3	**Excavation:** Using Crown's Machine @ $85/hr		
	750 m x 1.05 m^3/m = 787 m^3 x $3/$m^3$		
	2,361		2,400.00
1.4	**Survey Layout** - 2 men for one day		500.00
1.5	**Bedding Material:** Use Crown's pit or gravel bar from 10 km away		
	2 Trucks + 1 Loader = 40 yds/hr @$175/hr		
	Allow $6.50/$M^3$		
	.4 m^3/m x 750 m = 300 m^3 @ $6.50	1,950.00	2,000.00
1.6	**Backfill Placement:** (same as excavation)		2,400.00
1.7	**Pipe Positioning:** (10 min/section)		
	Crew of 2 + Hiab @ $105/hr		
	128 Section @ $17.50	2,240.00	2,300.00

1.8	**Pipe Laying**		
	10 min/pipe x 4 man crew @ $120/m		
	128 Sections @ $20.00	$ 2,560.00	$ 2,700.00
1.9	**Compaction**		
	1 min/lin meter x 750 x $30/hr	375.00	400.00
1.10	**Backfill** (1/2 the cost of bedding)		1,200.00
1.11	**Testing** (included with other activities)		
1.12	**Superintendence**		
	Based on 123 crew hours (15 days) @ $300/day		4,500.00
	Total Direct Costs		**$53,300.00**
	INDIRECT COSTS OF PENSTOCK INSTALLATION		
1.13	**Accommodation**		
	15 days x 4 x 35 = $2,100		$ 2,100.00
1.14	**Travel**		
	4 @ $350 + 12 hours 30 x 4		2,840.00
1.15	**Benefits** (included in charge out rates)		
1.16	**Office Liaison**		
	15 days @ $20/hr		2,400.00
1.17	**Truck**		
	15 days @ $40		600.00
1.18	Contingency at 10%		6,100.00

1.19	Profit @ 10%		$ 6,100.00
	Total Indirect Costs		20,140.00
	Total Penstock Cost		73,440.00
	Average Installed Cost	**$ 97.92/m**	

2. TURBINE/GENERATOR/SWITCHGEAR COSTS

90 kW 105 m head
Highland Energy Estimate 86,000.00

3. ACCESS ROAD COST

Length = 400 m Width = 4 m
Potential Volumes = 2 m^3 cut/2 m^3 fill (per metre)
= 600 m^3 cf/600 m^3 fill

Method 1: Using average logging road cost of 90,000/mile

= 55,000/km
x .5 (1 lane)
x .3 km
$ 8,250.00

Method 2: Using factored dozer production rate of 27 Bank m^3/hr

Actual Time $= \frac{600 \times 2}{27}$ = 44 hrs @ $115/hr
= $5,000.00

Gravel: 300 m x .5 x 4 = 600 m^3
x $6.50/$m^3$
$3,900.00

Total $ 8,900.00

Use $10,000.00

4. INTAKE COST (UNIT PRICES)

4.1	Bell Mouth		$ 500.00	$
4.2	Butterfly Valve		500.00	
4.3	Air Vent		200.00	
4.4	Trash Bars (Armco "88" Aluminum) 30ft^2		1,000.00	
4.5	Steel Pipe	6.0 m, 230 kg	1,300.00	
4.6	Concrete	4.8 m^3 @ $2,600	12,000.00	
4.7	Miscellaneous Preparation		4,000.00	
			19,900.00	20,000.00

5. POWERHOUSE

Base Size Approximately 3.2 m x 3.5 m

5.1	Foundation	4.8 m^3 @ $2,000	9,600.00	
5.2	Superstructure	$99/m^2 (Walls & Roof)	4,100.00	
5.3	Door	2 @ 500		1,000.00
5.4	Turbine Installation			6,000.00
5.5	Site Preparation			500.00
5.6	Terminal Reducing Anchor	1.5 m^3 @ 2000		3,000.00

5.7	Steel Transition	6 m @ 300 = 1800		$ 2,000.00
5.8	Butterfly Valve			1000.00
5.9	Coupling			200.00
			Total	**$27,200.00**

Note: The above cost is based on a minimum size power house for the 75 kW size. Scaled up for the 90 kW plant the Factored cost is $28,215.

6. ELECTRICAL COSTS

Including pole line, revenue meter, transformers, powerhouse circuits, electronic frequency control and breakers.

Vancouver Cost	$24,500.00	
Moses Inlet Cost	41,000.00	41,000.00

7. ENGINEERING COSTS

7.1 **Survey**

2 men for 3 days + 1½ travel	3,168.00
Travel, Accommodation, Expenses	1,000.00
	4,168.00

7.2 **Site Plans**

3 days Engineering @ 300	900.00
2 days Drafting @ 280	569.00
	1,460.00

7.3 Final Design

Intake	2 days @ 300	$ 600.00
Penstock	2 days @ 300	600.00
Powerhouse	4 days @ 300	1,200.00
Electrical	3 days @ 450	1,350.00
Miscellaneous	2 days @ 400	800.00
Drafting	12 days @ 280 x 1.5	5,040.00
Project Engineer	3 days @ 350	1,050.00
Project Manager	2 days @ 450	900.00
		$11,540.00

7.4 Field Inspection

Set out	(1 visit) 3 days @ 300	900.00
Penstock	(3 visits) 6 days @ 300	1,800.00
Electrical	(1 visit) 3 days @ 450	1,350.00
Intake	(1 visit) 2 days @ 300	600.00
Commissioning	(1 visit) 3 days @ 300	900.00
	3 days @ 400	1,350.00
Project Engineer	(General) 5 days @ 350	1,750.00
Project Engineer	(visits) 2 @ 350 x 2	1,400.00
Project Manager	2 days @ 450	900.00
Expenses	10 trips @ 450	4,000.00
Miscellaneous		1,000.00
Total		**$15,350.00**

7.5	**As-Built Drawings**			
	Engineering	2 days @ 300	$ 600.00	$
	Drafting	2 days @ 280	560.00	
	Project Engineer	1 day @ 350	350.00	
			$ 1,550.00	
7.6	**Operation and Maintenance Manual**			
	Text	40 pages @ 1.5 hr x 48	2,880.00	
	Word Processing	20 hrs @ 30	600.00	
	Photos		50.00	
	Printing		100.00	
			$ 3,630.00	
	TOTAL		$38,298.00	$40,000.00

TABLE 6.3
DEVELOPMENT COSTS

Owner's administration costs during construction	
5 hrs/week x 20 weeks x $40/hr	$ 4,000
Legal fees to set contracts	3,000
Interest during construction	
14% x 6 months x $\frac{300,000}{2}$	10,500
TOTAL START-UP COSTS	$ 17,500

Use 6% of Construction Cost

ADMINISTRATION COSTS

Monthly:	Administration 1 day/month x 8 hrs x 40	320
	Miscellaneous	80
		400
Annual:	Water Licence 1.99 per 1000 kW.h	800
	2.85 per kW	250
	Land Lease	300
		1,350
	Administration/Miscellaneous 12 x 400	4,800
TOTAL ANNUAL COSTS		$ 6,150
	Allow	$ 7,000

NOTE: These allowances are built into the costs shown in Table 6.1 and Table 7.1.

TABLE 6.4

MAINTENANCE COSTS

DAILY CHECK: 0.25 hrs x $20 x 365		$ 1,825
ALLOWANCE FOR TECHNICIAN		
2 trips x 4 days		2,240
Travel Expenses		1,000
		3,240
LUBRICANTS : EXPENDABLES		200
INTAKE CLEANOUT	3 @ 150 (with machine)	450
SPARE PARTS	(Allow $3000)	3,000
TOTAL ANNUAL COSTS		$ 8,715
	Allow	$ 9,000

7. FINANCIAL ANALYSIS

7.1 COST OF POWER FOR VARIOUS SCHEMES AND OPTIONS

The objective of this study is to decide upon a power generation scheme which maximizes the rate of return on investment. Whereas some hydro power schemes would be attempting to produce the least cost of power to supply all of the camp power, or to maximize the power output of a given site, this project must consider the variable energy use pattern of the camp, the variable supply of water in the stream and the cost of delivered power relative to the cost of diesel generation. At the same time, normal operation of the camp cannot be compromised as its prime purpose is to harvest timber and not optimize hydro power production. In most cases the plant with the least cost of delivered power will maximize the investment, hence the methodology used was to find the least cost plant and test various financial scenarios.

The total annual cost of power is comprised of the amortized capital cost, the daily maintenance cost, routine inspections, an allowance for emergency repairs and the costs of administrating the project. Administration would include keeping production records, billing the customer, arranging for repairs and paying for water licence fees. The annual cost of power for the various options of the simplest schemes has been presented in Table 6.1. This table has been used to define the optimum range of project size for further analysis. Subsequently a few of the optimum projects have been tested with the variables shown below.

The energy estimates for various project options are determined by taking the total theoretical energy (installed capacity x 8760 hrs/year)and deducting the following:

- deficits due to insufficient flow;
- deficits due to diesel minimum load requirements;
- low demand from the camp;
- allowance for downtime;
- effect of no energy management;
- effect of flow supplementation.

The plant owner has little control over any of these deficits except the downtime. Insufficient flow is a function of the local hydrology and can be partly supplemented by the diversion of the adjacent creek and the construction of an intake structure at the lake. Additional energy provided by this can be weighed against the extra cost of the additional structures.

Deficits from the minimum diesel load requirement are due to the necessity of always having some load on the diesel generators. Thus when parallel operation is necessary (expected load greater than the hydro plant capacity) there is some loss in hydro plant energy production which is recovered if the system load increases. This deficit can be minimized by using smaller diesel generators. Several combinations have been tested and it has been conservatively assumed that the diesel must run at a minimum 50% of its capacity.

Low demand from the camp is a function of weather, crew size and camp energy management practices. In the examples we have assumed normal weather conditions, crew sizes as predicted by Crown Forest and camp energy management to reduce peak heating loads. It is also possible that the camp will operate on a 10 days on 4 days off system as in the past. The crew leaves camp during the days off, so the loads are reduced. The effect of no energy management is shown as an alternative.

The allowance for downtime has been set at 5% of the time of operation (or 5% of the theoretical total less the preceding deficits). This figure is based on recent experience with small hydro power plants in British Columbia which has shown downtimes of 2% to 5%. Proper regular maintenance can reduce downtime caused by major repairs.

All of the above deficits result in a reduced load factor on the plant. Stating the load factor expresses the ratio of: Total Expected Load/(Plant Capacity x 8760).

The load factor estimates for various scenarios are shown in Table 7.1. The cost of power is determined by dividing the annual cost of energy for each scheme by its estimated energy production. The value, in cents per kilowatt-hour can be compared with the value of the diesel fuel saved presented in Section 2.4.

7.2 DISCOUNTED CASH FLOW ANALYSIS

There are many variables involved in the discounted cash flow analysis and additional variables in the selected option. For this report, the least cost, most likely scenario was selected for discounted cash flow analysis, namely a 75 kW plant at the lower intake site, with energy management and a 100 kW diesel generation plant to share the load when flows are insufficient to generate camp demand. The camp was assumed to operate at 40 man average occupation from March to November inclusive with no allowance for decreased crew.

The variables examined in the discounted cash flow analysis included the target discount rate, camp life and rate of diesel price rise. Ten year amortization, 15% target discount rate (or desired rate of return) and 1% diesel price rise (in real terms) were considered the base case so that while one rate was varied the others were held constant at the base case.

The discounted cash flow analysis calculates the internal rate of return on the project over the project life given the various assumptions. The rate of return is highest with an accelerated capital cost allowance, long lifespan, lower capital cost and high rate of diesel price increase. The various rates of return are shown in Table 7.2. The after tax present value is calculated based on the required rate of return and is negative if the required rate of return is less than the internal rate of return.

Table 7.2 - Financial Analysis

This table takes several financial options and examines them against the previous option in Table 7.1 at 75 kW capacity. The first 8 trials are based on standard capitalization procedures while the last 2 trials examine the effect of leasing the project at a fixed rate for 10 years with a buyout at the end. The effect of accelerated and standard capital cost allowance is also shown.

7.3 CONCLUSIONS FROM FINANCIAL ANALYSIS

Most conclusions relating to the Moses Inlet project can be drawn from Tables 6.1, 7.1 and 7.2. Table 6.1 indicates the sensitivity of various plant sizes to the cost of power. There is a trade-off between the economy of scale achieved with larger plants and the consequent reduced load factor with the lower end of the range being favoured. Even so, the cost per kilowatt only varies slightly for different plant sizes so that if other attractive considerations were involved (such as a discount on a particular size pipe or turbine) the balance could easily be shifted.

Subsequently a number of other alternatives were presented in Table 7.1. These were all based on Table 6.1 where there was the assumption of a full 70 man crew from March to November inclusive, and energy management unless stated otherwise. The options would change the cost of power but the ranking of projects would only shift by at most one position. The effect on energy cost can be summarized as follows in relation to the base case:

Variable	Effect on Energy Cost
10 year amortization to 20 year	Reduces cost by 25%
Without energy management (ie. fast recovery water heaters)	Increases cost by 13.5%
Split shift schedule with no men in camp 4 days out of 14	Increases cost by 12%
Lake flow only (no upper creek intake, only natural regulation)	Increases cost by 2%
Diesel load shared with 100 kW generator (when plant capacity insufficient)	Increases cost by 12%
Diesel load shared with 50 kW generator (when plant capacity insufficient)	Increases cost by 4%
Downtime and maintenance at 5%	Increases cost by 5%
Combined basins with flow regulation at lake	Increases cost by 4%

TABLE 7.1
COSTS OF ALTERNATIVE SCENARIOS
(Based on Full Camp)

CAPACITY	HEAD	POWER	PENSTOCK	INTAKE	POWERHOUSE	ELECTRIC	ACCESS	UPPERINT	TURBINE	SUBTOTAL	ENG'NG	TOTAL	FLOWFRAC	LOADFACT	$INDEX
1.00	105.00	75.00	73440.00	20000.00	27000.00	41000.00	10000.00	12300.00	73000.00	256740.00	40000.00	314544.40	.43	.81	10.87
2.00	105.00	80.00	73440.00	20000.00	27485.00	41400.00	10000.00	12300.00	78000.00	262545.00	40000.00	320697.70	.46	.78	10.72
3.00	105.00	85.00	73440.00	20000.00	27810.00	41800.00	10000.00	12300.00	82000.00	267350.00	40000.00	325791.00	.49	.76	10.58
4.00	105.00	90.00	73440.00	20000.00	28215.00	42200.00	10000.00	12300.00	86000.00	272155.00	40000.00	330884.30	.52	.73	10.50
5.00	125.00	95.20	75170.00	23000.00	28620.00	42600.00	10000.00	12300.00	90000.00	281690.00	40000.00	340991.40	.54	.70	10.54
6.00	105.00	100.00	76900.00	23000.00	29025.00	43000.00	10000.00	12300.00	94000.00	288225.00	40000.00	347918.50	.58	.67	10.63
7.00	105.00	110.00	80360.00	23000.00	29430.00	44200.00	10000.00	12300.00	104000.00	303290.00	40000.00	363887.40	.63	.62	10.83
8.00	105.00	120.00	83820.00	23000.00	29835.00	45400.00	10000.00	12300.00	111000.00	315355.00	40000.00	376676.30	.69	.57	11.07
9.00	105.00	130.00	87280.00	23000.00	30240.00	46600.00	10000.00	12300.00	120000.00	328820.00	40000.00	390949.20	.75	.53	11.38
10.00	105.00	140.00	90740.00	23000.00	30645.00	46000.00	10000.00	12300.00	127000.00	339685.00	40000.00	402466.10	.79	.49	11.59
11.00	140.00	90.00	94340.00	20000.00	31320.00	42200.00	16000.00	12300.00	76000.00	292160.00	40000.00	352089.60	.39	.74	10.82
12.00	140.00	100.00	94340.00	20000.00	31860.00	43000.00	16000.00	12300.00	82000.00	299500.00	40000.00	359870.00	.43	.70	10.48
13.00	140.00	110.00	94340.00	20000.00	32400.00	44200.00	16000.00	12300.00	88000.00	307240.00	40000.00	368074.40	.48	.64	10.53
14.00	140.00	120.00	97311.20	20000.00	32670.00	45400.00	16000.00	12300.00	95000.00	318681.20	40000.00	380202.07	.52	.59	10.71
15.00	140.00	130.00	100282.40	23000.00	33210.00	46000.00	16000.00	12300.00	101000.00	331792.40	40000.00	394099.94	.56	.55	10.99
16.00	140.00	140.00	103253.60	23000.00	33750.00	46000.00	16000.00	12300.00	107000.00	341303.60	40000.00	404181.82	.60	.51	11.18
17.00	140.00	150.00	106224.80	23000.00	34155.00	46000.00	16000.00	12300.00	112000.00	349679.80	40000.00	413060.59	.63	.48	11.32
18.00	140.00	160.00	110186.40	23000.00	34560.00	47600.00	16000.00	12300.00	119000.00	362646.40	40000.00	426805.18	.69	.45	11.69
19.00	140.00	170.00	114148.00	23000.00	35100.00	49200.00	16000.00	12300.00	124000.00	373748.00	40000.00	438572.88	.74	.42	11.94
20.00	140.00	180.00	114148.00	23000.00	35370.00	51000.00	16000.00	12300.00	128000.00	379818.00	40000.00	445007.08	.78	.40	12.07

105m 75ø LONG= 73440.00 25ø0m INTAKE= 20000.00 ACCESS TO 105m= 10000.00 CAPITAL RECOVERY= .13

140m 75ø LONG= 90740.00 30ø0m INTAKE= 23000.00 ACCESS TO 140m= 16000.00 MAINTENANCE = 16000.00

140m 92ø LONG= 94340.00 UPPER INTAKE= 12300.00 AND ADMIN.

140m 98ø LONG= 114148.00 POWERHOUSE= 27000.00 ENGINEERING= 40000.00 DEVEL.$= 1.06

WITHOUT ENERGY MANAGEMENT

3.00	105.00	85.00	73440.00	20000.00	27810.00	41800.00	10000.00	12300.00	82000.00	267350.00	40000.00	325791.00	.49	.67	14.73
4.00	105.00	90.00	73440.00	20000.00	28215.00	42200.00	10000.00	12300.00	86000.00	272155.00	40000.00	330884.30	.52	.64	14.73
5.00	105.00	95.00	75170.00	23000.00	28620.00	42600.00	10000.00	12300.00	90000.00	281690.00	40000.00	340991.40	.54	.62	14.86
11.00	140.00	90.00	94340.00	20000.00	31320.00	42200.00	16000.00	12300.00	76000.00	292160.00	40000.00	352089.60	.39	.66	14.98
12.00	140.00	100.00	94340.00	20000.00	31860.00	43000.00	16000.00	12300.00	82000.00	299500.00	40000.00	359870.00	.43	.61	14.86
13.00	140.00	110.00	94340.00	20000.00	32400.00	44200.00	16000.00	12300.00	88000.00	307240.00	40000.00	368074.40	.48	.57	14.81

(Upper part of table shows full range with capital recovery of .13. Lower part of table (Without Energy Management) is based on capital recovery of .18).

SHIFT SCHEDULE:10 DAYS ON /4 DAYS OFF

3.00	105.00	85.00	73440.00	20000.00	27810.00	41800.00	10000.00	12300.00	82000.00	267350.00	40000.00	325791.00	.49	.66	14.98
4.00	105.00	90.00	73440.00	20000.00	28215.00	42200.00	10000.00	12300.00	86000.00	272155.00	40000.00	330884.30	.52	.64	14.76
5.00	105.00	95.00	75170.00	23000.00	28620.00	42600.00	10000.00	12300.00	90000.00	281690.00	40000.00	340991.40	.54	.65	14.10
11.00	140.00	90.00	94340.00	20000.00	31320.00	42200.00	16000.00	12300.00	76000.00	292160.00	40000.00	352089.60	.39	.65	15.27
12.00	140.00	100.00	94340.00	20000.00	31860.00	43000.00	16000.00	12300.00	82000.00	299500.00	40000.00	359870.00	.43	.61	14.98
13.00	140.00	110.00	94340.00	20000.00	32400.00	44200.00	16000.00	12300.00	88000.00	307240.00	40000.00	368074.40	.48	.56	15.02

LAKE FLOW ONLY

3.00	105.00	85.00	73440.00	20000.00	27810.00	41800.00	10000.00	.00	82000.00	255850.00	40000.00	312753.00	.90	.72	13.37
4.00	105.00	90.00	73440.00	20000.00	28215.00	42200.00	10000.00	.00	86000.00	259855.00	40000.00	317846.30	.95	.69	13.32
5.00	105.00	95.00	75170.00	23000.00	28620.00	42600.00	10000.00	.00	90000.00	269390.00	40000.00	327953.40	.99	.66	13.43
11.00	140.00	90.00	94340.00	20000.00	31320.00	42200.00	16000.00	.00	76000.00	279860.00	40000.00	339851.60	.72	.73	13.20
12.00	140.00	100.00	94340.00	20000.00	31860.00	43000.00	16000.00	.00	82000.00	287200.00	40000.00	346832.00	.79	.67	13.11
13.00	140.00	110.00	94340.00	20000.00	32400.00	44200.00	16000.00	.00	88000.00	294940.00	40000.00	355036.40	.88	.62	13.23

DIESEL LOAD SHARE:100 KW GENERATOR

3.00	105.00	85.00	73440.00	20000.00	27810.00	41800.00	10000.00	12300.00	82000.00	267350.00	40000.00	325791.00	.49	.68	14.62
4.00	105.00	90.00	73440.00	20000.00	28215.00	42200.00	10000.00	12300.00	86000.00	272155.00	40000.00	330884.30	.52	.65	14.56
5.00	105.00	95.00	75170.00	23000.00	28620.00	42600.00	10000.00	12300.00	90000.00	281690.00	40000.00	340991.40	.54	.63	14.59
11.00	140.00	90.00	94340.00	20000.00	31320.00	42200.00	16000.00	12300.00	76000.00	292160.00	40000.00	352089.60	.39	.70	14.20
12.00	140.00	100.00	94340.00	20000.00	31860.00	43000.00	16000.00	12300.00	82000.00	299500.00	40000.00	359870.00	.43	.65	14.06
13.00	140.00	110.00	94340.00	20000.00	32400.00	44200.00	16000.00	12300.00	88000.00	307240.00	40000.00	368074.40	.48	.59	14.16

DIESEL LOAD SHARE:50 KW GENERATOR

3.00	105.00	85.00	73440.00	20000.00	27810.00	41800.00	10000.00	12300.00	82000.00	267350.00	40000.00	325791.00	.49	.73	13.63
4.00	105.00	90.00	73440.00	20000.00	28215.00	42200.00	10000.00	12300.00	86000.00	272155.00	40000.00	330884.30	.52	.70	13.54
5.00	105.00	95.00	75170.00	23000.00	28620.00	42600.00	10000.00	12300.00	90000.00	281690.00	40000.00	340991.40	.54	.67	13.61
11.00	140.00	90.00	94340.00	20000.00	31320.00	42200.00	16000.00	12300.00	76000.00	292160.00	40000.00	352089.60	.39	.73	13.56
12.00	140.00	100.00	94340.00	20000.00	31860.00	43000.00	16000.00	12300.00	82000.00	299500.00	40000.00	359870.00	.43	.68	13.43
13.00	140.00	110.00	94340.00	20000.00	32400.00	44200.00	16000.00	12300.00	88000.00	307240.00	40000.00	368074.40	.48	.63	13.43

TABLE 7.1

Based on Full Camp Capital Recovery of .18, Energy Management Except as Noted.

DOWNTIME AND MAINTENANCE AT 5%

3.00	105.00	85.00	73440.00	20000.00	27810.00	41800.00	10000.00	12300.00	82000.00	267350.00	40000.00	325791.00	.49	.72	13.69
4.00	105.00	90.00	73440.00	20000.00	28215.00	42200.00	10000.00	12300.00	86000.00	272155.00	40000.00	330884.30	.52	.69	13.63
5.00	105.00	95.00	75170.00	23000.00	28620.00	42600.00	10000.00	12300.00	90000.00	281690.00	40000.00	340991.40	.54	.67	13.78
11.00	140.00	90.00	94340.00	20000.00	31320.00	42200.00	16000.00	12300.00	76000.00	292160.00	40000.00	352089.60	.39	.70	14.12
12.00	140.00	100.00	94340.00	20000.00	31860.00	43000.00	16000.00	12300.00	82000.00	299500.00	40000.00	359870.00	.43	.67	13.67
13.00	140.00	110.00	94340.00	20000.00	32400.00	44200.00	16000.00	12300.00	88000.00	307240.00	40000.00	368074.40	.48	.61	13.84

COMBINED BASINS WITH FLOW REGULATION AT LAKE

3.00	105.00	85.00	73440.00	20000.00	27810.00	41800.00	10000.00	32300.00	82000.00	287350.00	40000.00	346991.00	.49	.77	13.49
4.00	105.00	90.00	73440.00	20000.00	28215.00	42200.00	10000.00	32300.00	86000.00	292155.00	40000.00	352084.30	.52	.74	13.36
5.00	105.00	95.00	75170.00	23000.00	28620.00	42600.00	10000.00	32300.00	90000.00	301690.00	40000.00	362191.40	.54	.72	13.41
11.00	140.00	90.00	94340.00	20000.00	31320.00	42200.00	16000.00	32300.00	76000.00	312160.00	40000.00	373289.60	.39	.76	13.73
12.00	140.00	100.00	94340.00	20000.00	31860.00	43000.00	16000.00	32300.00	82000.00	319500.00	40000.00	381070.00	.43	.70	13.55
13.00	140.00	110.00	94340.00	20000.00	32400.00	44200.00	16000.00	32300.00	88000.00	327240.00	40000.00	389274.40	.48	.65	13.59

LAKE FLOW ONLY, 40 MAN CAMP, 5% DOWNTIME, ENERGY MANAGEMENT, 100 KW DIESEL LOAD SHARE

1.00	105.00	75.00	73440.00	20000.00	27000.00	41000.00	10000.00	.00	73000.00	244440.00	40000.00	301586.40	.79	.58	18.15
2.00	105.00	80.00	73440.00	20000.00	27405.00	41400.00	10000.00	.00	78000.00	258245.00	40000.00	307659.70	.84	.55	18.26
3.00	105.00	85.00	73440.00	20000.00	27810.00	41800.00	10000.00	.00	82000.00	255050.00	40000.00	312753.00	.90	.52	18.41
4.00	105.00	90.00	73440.00	20000.00	28215.00	42200.00	10000.00	.00	86000.00	259855.00	40000.00	317846.30	.95	.50	18.42
5.00	105.00	95.00	75170.00	23000.00	28620.00	42600.00	10000.00	.00	90000.00	269390.00	40000.00	327953.40	.99	.48	18.72
10.00	140.00	80.00	94340.00	20000.00	30780.00	41600.00	16000.00	.00	70000.00	272720.00	40000.00	331483.20	.64	.62	17.18
11.00	140.00	90.00	94340.00	20000.00	31320.00	42200.00	16000.00	.00	76000.00	279860.00	40000.00	339051.60	.72	.56	17.26
12.00	140.00	100.00	94340.00	20000.00	31860.00	43000.00	16000.00	.00	82000.00	287200.00	40000.00	346832.00	.79	.51	17.44
13.00	140.00	110.00	94340.00	20000.00	32400.00	44200.00	16000.00	.00	88000.00	294940.00	40000.00	355036.40	.88	.45	18.01

UPPER CREEK INTAKE=

TABLE 7.2

FINANCIAL ANALYSIS

NOTE: Results based on 75 kW plant, 105 m head, energy management, 40 man camp and load share with 100 kW diesel.

Trial		1	2	3	4	5	6	7	8	9	10
Time Horizon	(yrs)	10	5	20	10	10	10	10	10	10	10
Desired Rate of Return	(%)	15	15	15	10	20	15	15	15	15	15
Power Inflation Rate	(%)	8	8	8	8	8	7	9	8	0	0
General Inflation Rate	(%)	7	7	7	7	7	7	7	7	0	0
Equity	(%)	100	100	100	100	100	100	100	100	100	100
Amortization Period	(yrs)	10	5	20	10	10	10	10	10	10	10
Income Tax Rate	(%)	25	25	25	25	25	25	25	25	25	25
Development Period	(yrs)	1	1	1	1	1	1	1	1	1	1
Management Fee	(%)	6	6	6	6	6	6	6	6	6	6
CCA (-1=Accelerated)	(%)	-1	6	6	6	6	6	6	6	-1	6
Sale Price	(mills)	150	150	150	150	150	150	150	150	150	150
Construction Cost	($)	286	286	286	286	286	286	286	286	200	200
Present Value Before Tax	($)	2.7	-110.8	149.3	75.1	-45.0	-13.4	19.7	2.7	16.8	16.8
Present Value After Tax	($)	-13.8	-144.0	46.1	-12.6	-96.9	-76.0	-51.2	-63.9	1.5	-33.5
IRR After Tax	(%)	13.6	-11.8	17.3	9.1	9.1	7.7	10.4	9.1	15.2	10.0

A further modification was made to evolve the design case, which involved the summation of all the most likely variables. This consisted of a 40 man average crew size from March to November, energy management, lake flow only, 100 kW diesel plant to share the load and a 5% allowance for maintenance and downtime. The range of options was broadened downward to include smaller capacities and the optimum plant size became 75 kW at a head of 105 m or 80 kW at a head of 140 m. This range should be considered the least costly, subject to further revision of the camp operating conditions, the reduction of the construction costs in specific areas, and the conditions of the Power Sales Contract.

The financial analysis presented in Table 7.2 was based on the above design case, and included various options. The options could always be varied to obtain a higher rate of return, but using realistic assumptions of 10 year amortization, 6% capital cost allowance and 1% rate of diesel fuel increase, the rate of return is 9.1% after taxes. The plant will have a residual value at the end of 10 years and could be sold to Crown Forest by Lancaster for an amount to be agreed in the Power Sales Contract.

8. INVESTMENT RISK ASSESSMENT

Any business investment is subject to uncertainties after a commitment has been made, which may render the project either less or more profitable than expected. This section lists the major investment risks for a hydro power plant substituting for diesel generation. It assesses such risks in terms of their impact on the rate of return on investment.

8.1 RISK FACTORS

A simple formula for the rate of return on investment of the hydro power plant in any given year is:

$$\text{rate of return} = \frac{(\text{annual saved diesel costs}) - (\text{annual hydro maintenance cost})}{(\text{hydro capital cost})}$$

in turn, the saved diesel costs can be expressed as

$$\text{annual saved diesel costs} = (\text{annual hydro energy used in kW.h}) \times (\text{cost per kW.h of diesel generation})$$

and also in turn,

$$\text{cost per kW.h of diesel generation} = (\text{diesel maintenance per kW.h}) + (\text{cost of diesel fuel per litre}) \times \text{constant}$$

In other words, the rate of return from the hydro power project in any given year depends on five main independent factors, which are:

1. Annual hydro energy used in kW.h
2. Diesel maintenance cost per kW.h
3. Cost of diesel fuel per litre
4. Annual hydro maintenance cost
5. Hydro capital cost

Over the entire life of the project, its overall rate of return also depends on its lifespan, i.e.

6. Number of years of operation of hydro plant.

Table 8-1 shows the calculated sensitivity of the rate of return from the project to these six factors for the plant size and design recommended in preceding sections of this report.

8.2 RISK ASSESSMENT

Table 8-2 breaks down each of the major risk factors into components and assigns a subjective probability (low, medium, high) that the component's actual value will be different from that which has been used in the preceding financial and economic analysis.

TABLE 8.1

SENSITIVITY OF RATE OF RETURN

A 10% increase (decrease in:)		Will result in an increase (decrease) in rate of return of
1.	Annual hydro energy used	+ 2.0 percentage points
2.	Diesel maintenance cost per kW.h	+ 0.3 percentage points
3.	Cost of diesel fuel per litre	+ 1.7 percentage points
4.	Annual hydro maintenance cost	- 0.6 percentage points
5.	Hydro capital cost	- 1.4 percentage points
6.	An increase from 10 to 20 years in lifespan	+ 3.5 percentage points

TABLE 8.2

COMPONENTS OF RISK FACTORS
AND RISK ASSESSMENT

Risk Factor Components	Assessment of Risk*
1. Annual Hydro Energy Used	
a) Generating capacity components	
- stream flow	medium
- plant downtime - accidents - human error - Acts of God - vandalism - design/construction faults	low
b) Power demand components	
- daily demand pattern	low
- seasonal demand pattern	low
- camp shutdown for part of year - strikes - lockouts - log market conditions	medium
2. Diesel Maintenance Cost per kW.h	low
3. Cost of Diesel Fuel per Litre	
- world oil prices	high
- federal/provincial fuel taxes	high
- transport cost to site	low
4. Annual Hydro Maintenance Cost	
- degree of wear and tear on hydro plant	low
- unit cost of labour and maintenance materials	medium

Risk Factor Components	Assessment of Risk*
5. Hydro Capital Cost	
- penstock	medium
- turbine/generator/switchgear	medium
- access road	low
- intake	high
- powerhouse	low
- electrical	low
- engineering	medium
6. Lifespan (number of years of operation)	
- future decisions by camp operator based on markets for forest products in the medium-to long-term	high

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* i.e. subjective probability that the actual condition or value of the risk component will be **significantly different** from the condition or value assumed in calculations in this study.

8.3 CONCLUSIONS OF RISK ASSESSMENT

Those risks which have a small impact on the rate of return from the project (low sensitivity) and which have a low probability can be ignored. On the other hand, those which have a larger impact on the rate of return and also have higher probability are significant.

By cross-referencing Tables 8-1 and 8-2, the higher-sensitivity, higher probability factors can be identified. These are shown in Table 8-3.

TABLE 8.3

IMPORTANT RISK FACTORS

Factor	Wholly or Partly Controllable by:	Impact of Increase in Factor on Rate of Return:
a) Cost of diesel fuel	Neither party	positive
b) Hydro plant capital cost	Supplier	negative
c) Lifespan of camp	User	positive
A fourth factor of lesser but significant importance is:		
d) Annual hydro energy used	User	positive

Overall, this project represents a moderate risk.

9. POWER CONTRACT OPTIONS REVIEW

In principle, under a two-party power contract, a supplier (Lancaster Resource Corporation) and a user (Crown Forest Industries Ltd) commit themselves to certain actions as a result of which each will benefit.

In the case of the Moses Inlet Hydro Power Plant a contract in effect determines how the total economic returns (of hydro replacing diesel) will be divided between the two parties, and what risks each will bear or share.

9.1 MAIN CONTRACT PROVISIONS

The main areas covered by a contract will be:

a) **what is to be supplied** by the supplier (e.g. electrical power at a given point at a given time, or an electrical plant of certain specifications, ancillary equipment such as protective electrical devices, etc).

b) the **price** or consideration to be paid by the user (e.g. a rate or lease formula).

c) the **term** of the contract.

d) a **buyout provision** under which the user may under given conditions shorten the term of the contract and take ownership of the plant.

e) **liability** provisions which make clear responsibility for loss or damage either to the hydro plant or to camp facilities due to malfunction, human error, or other unforeseen reasons.

f) **maintenance and operation** terms which establish responsibility for running the plant.

g) **assignment** clauses which allow or require either party to bind its successors or assigns to the contract.

9.2 MAIN CONTRACT TYPES

The central features determining the commercial character of the contract are a) the definition of what is being supplied and; b) the formula for payment by the user to the supplier.

Third-party financing arrangements are being increasingly used in the United States for renewable energy on energy conservation projects. There are four main contract types. They are:

a) **Equipment Lease.** The facility is built and financed and owned by the supplier and leased to the user (e.g. at a specified rate per month). The user is responsible for operation and (light) maintenance (analagous to a "U-drive" automobile lease).

b) **Mini-Utility.** The supplier sells power to the user at an agreed per-kW.h rate. Bulk discounts or off-peak discounts can be built into the tariff.

c) **Shared Savings.** The supplier sells power to the user on a per kW.h basis, but the per kW.h charge is set so that supplier and user share the savings resulting from the hydro plant in an agreed percentage. Accordingly, the rate per kW.h will change over time as the savings change (e.g. it would rise if diesel fuel prices rise, or would fall if fuel prices fall).

d) **Guaranteed Savings.** The supplier sells power to the user at a rate per kW.h which is guaranteed to be less than the cost of diesel generation by a fixed percentage. The four contract types are summarized in Table 9-1.

9.3 MAJOR DIFFERENCES OF CONTRACT TYPES

The contract types have two main differences:

a) They result in different exposure to risk for the two parties. For example, under the **lease** option the supplier does not gain (lose) if the hydro plant is more (less) intensively used by the user than originally expected. In the other three contract types the supplier shares the impact of higher or lower utilization.

As a further example, in both the **lease** and **mini-utility** options, the supplier does not gain (lose) if the price of diesel fuel rises (falls). All the benefits (costs) accrue to the user. In the **shared savings**, supplier and user share the benefits (costs) of diesel price increases (reductions). In **guaranteed savings**, in contrast, all benefits (costs) accrue to the supplier.

b) The contract types also differ in the type and degree of measurement of power consumption and power costs.

For example, the lease arrangement requires only an agreed periodic payment by the user to the supplier.

The other options all require that power consumption be metered at regular intervals. Further, shared savings and guaranteed savings require that a mutually acceptable costing formula be used to determine what generation costs **would have been** had the power been generated by **diesel** not hydro. Shared savings requires an additional agreement on the actual costs of generation by hydro, so that the savings can be calculated.

9.4 PREFERRED OPTION

Among factors to be weighed in selecting a contract type are:

- the advantages of simplicity to minimize contract administration costs and to minimize the chances of future misunderstandings of complex provisions;

- the principle that a party which has whole or partial control over a given risk factor should shoulder that risk under the contract (eg. the supplier should be exposed to the risk of capital cost variation, which is under his control; the user should be exposed to the risk of variation in power consumption, which he controls);

TABLE 9.1

POWER CONTRACT OPTIONS

L = Lancaster Resource Corporation (Supplier)
C = Crown Forest Industries Ltd (User)

	CONTRACT TYPE			
	Equipment Lease	Mini-Utility	Shared Savings	Guaranteed Savings
DEFINITION				
Financing, capital costs and ownership	L	L	L	L
Responsible for cost of maintenance	L or C	L or C	L or C	L
Form of payment by C to L	Rate per month or year	_____	Rate per kW.h used	_____
Rate determined by C and L agreement on	Rate lying between L's carrying costs plus maintenance (lower bound) and C's savings on eliminated diesel generation (upper bound).	Fixed (possibly escalating with time) per kW.h rate.	Weighted average of generation cost of hydro and diesel, per kW.h	Fixed percentage of cost of diesel generation (eg. 90%) per kW.h. Percentage may be changed over time.
EXPOSURE TO RISK FACTORS				
Hydro energy used per annum	C	L	L and C	L
Price of diesel fuel	C	C	L and C	L
Hydro maintenance costs	L or C	L	L and C	L
Capital cost of hydro plant	L	L	L and C	L
Lifespan	C	L	L and C	L and C
COMMENTS	Simple financial arrangement.		Requires continuous agreed estimates of diesel and hydro generating costs.	Requires continuous agreed estimates of diesel generating costs.

- risks under the control of **neither** party can be allocated to either or both under an agreed contract, and monetary terms in the contrct would naturally reflect who bears which uncontrollable risks.

For the Moses Hydro Power Plant, the above reasoning tends to favour a **lease contract** as the most suitable.

Referring to Tables 8.3 and 9.1, the **lease arrangement** is not only the simplest (requiring no agreement on metering of power consumption or a costing formula) but it also allocates the "controllable" risks appropriately. For the main uncontrollable risk (diesel fuel costs) it allocates the gains (losses) resulting from fuel cost increases (reductions) to the user.

10. FINDINGS AND CONCLUSIONS

The findings and conclusions of this study are best framed in terms of its original objectives, as follows:

Objective A: To determine the physical, economic and legal/contractual feasibility of a junior resource company substituting diesel with hydro power at the Moses Inlet Forestry Camp.

Finding/Conclusion: The finding is positive in all aspects of project feasibility. In particular, a 75 kW, 105 metre-head hydro plant can economically supply approximately 70% of the power requirements of the camp. The most feasible legal/contractual arrangement is a lease.

Objective B: To provide an adequate basis for negotiation between Lancaster and Crown Forest on a long term power contract.

Finding/Conclusion: In the final stages of writing this report, Lancaster was submitting a written proposal to Crown Forest to finance and build a hydro power plant.

Objective C: To provide Lancaster with sufficient hard data about the projects risks and returns to:

- approach the financial community for equity financing for all or some of the detailed design and construction costs; and/or
- approach other junior resource companies as partners.

Finding/Conclusion: During the final stages of writing this report, Lancaster began approaching financial institutions, using the information generated by this report to explain the project. As a result, Lancaster believes that equity and/or debt financing will be available as needed. There has also been interest in joint ventures by other junior resource companies.

Objective D: To help meet the goals of the Remote Community Demonstration Program of Energy, Mines and Resources Canada.

Finding/Conclusion: These goals lie in the demonstration value of the report, which is addressed in Section 11 following, and in the reduction of diesel fuel used, should the project go ahead (approximately 127,000 l/year).

11. INFORMATION TRANSFER POTENTIAL

A number of aspects of this report have potential for other remote community, off-oil projects.

Third-Party Financing

The principle of third-party financing of conservation and renewable energy projects has considerable potential. New corporations specializing in renewable/conservation projects are more able and likely to identify and initiate economic opportunities for conversions than companies whose major business focus is elsewhere (eg. in mining or forestry). When this can be combined with the ability to "sell" the concept to the financial community, and hence provide a complete design/construction/financing package to the energy user - then the user can be presented with a simple method of reducing operating costs at no capital outlay.

Key Contractual Types

As indicated in this study, there are at least four basically different ways for the third-party financier and the energy user to share the rewards and risks of the conversion. All of these have general application to off-oil, remote community projects.

Private Sector Capital for Off-Oil Projects in British Columbia

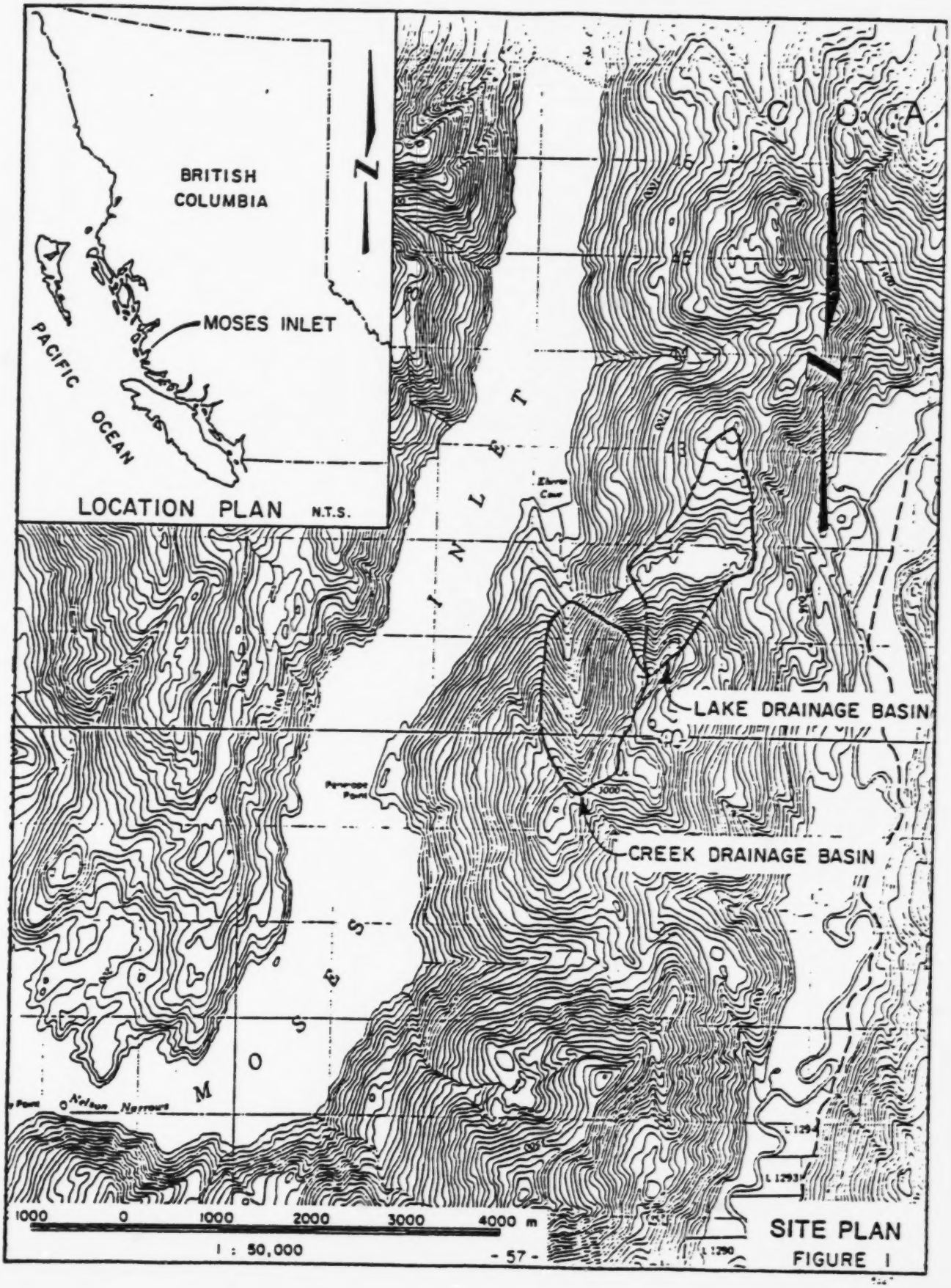
The local capital markets have favoured hardrock and oil and gas exploration ventures for many years. As a venture capital company recently listed on the Vancouver Stock Exchange, Lancaster believes that the awareness of the local community of investors to renewable/conservation projects and their economic appeal will increase as junior resource companies publicize their efforts and establish themselves in this field.

Hydro Power Plant Optimization in a Mixed System

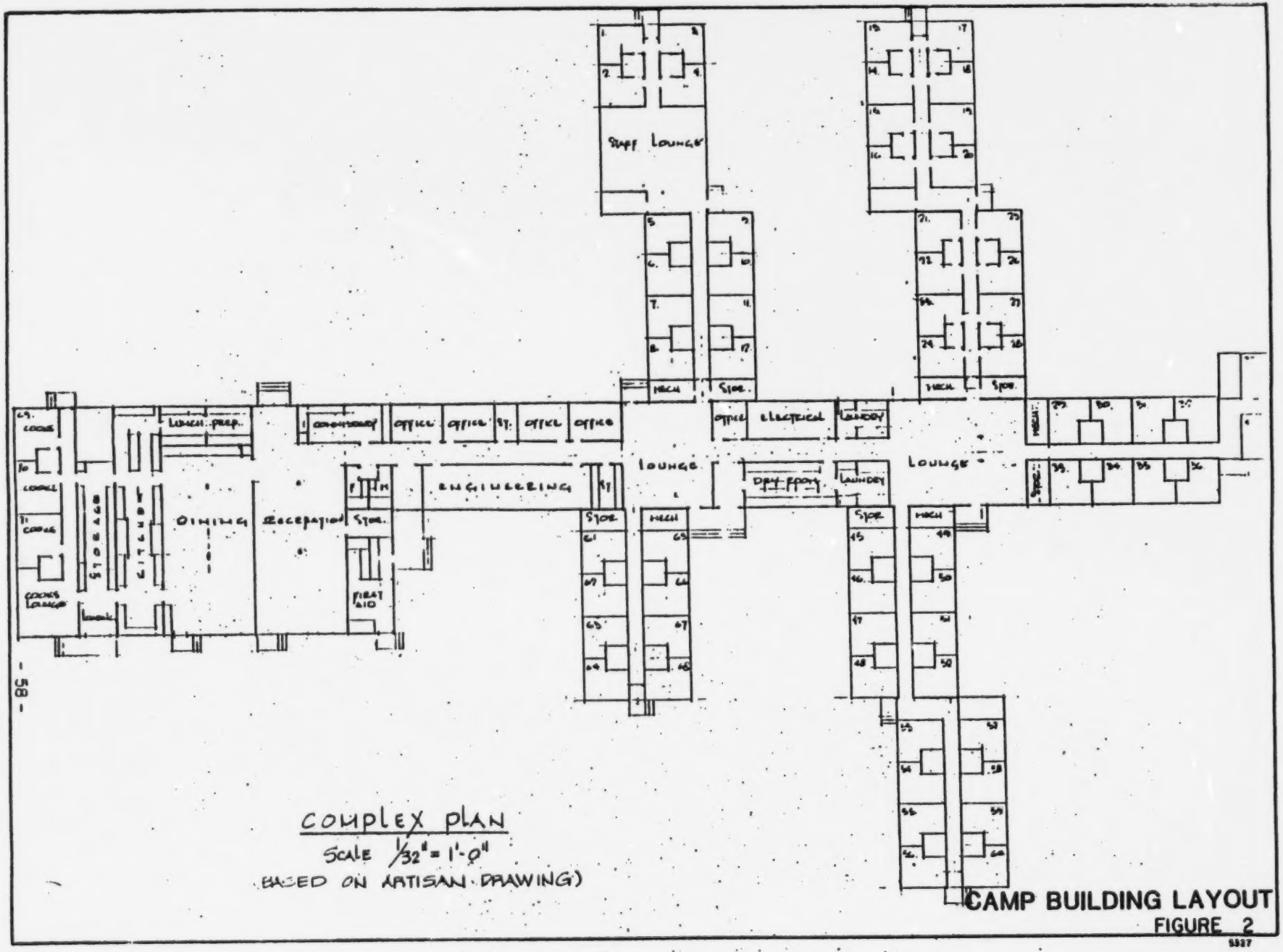
The technical design asepcts of this proposal have indicated the many variables that must be accounted for in order to have sufficient information for the investment decision. The report also indicates the importance of having good information on the expected loads, especially in the situation where there is a potential for wide variation.

Load Sharing Design Features and Energy Management Opportunities

The ability to increase the load factor and hence improve the investment return on a project depends on having advanced technology systems which can maximize the power output of the small hydro power system. The report demonstrates the significance of these measures and shows where they would fit in the system.



SITE PLAN
FIGURE 1



COMPLEX PLAN

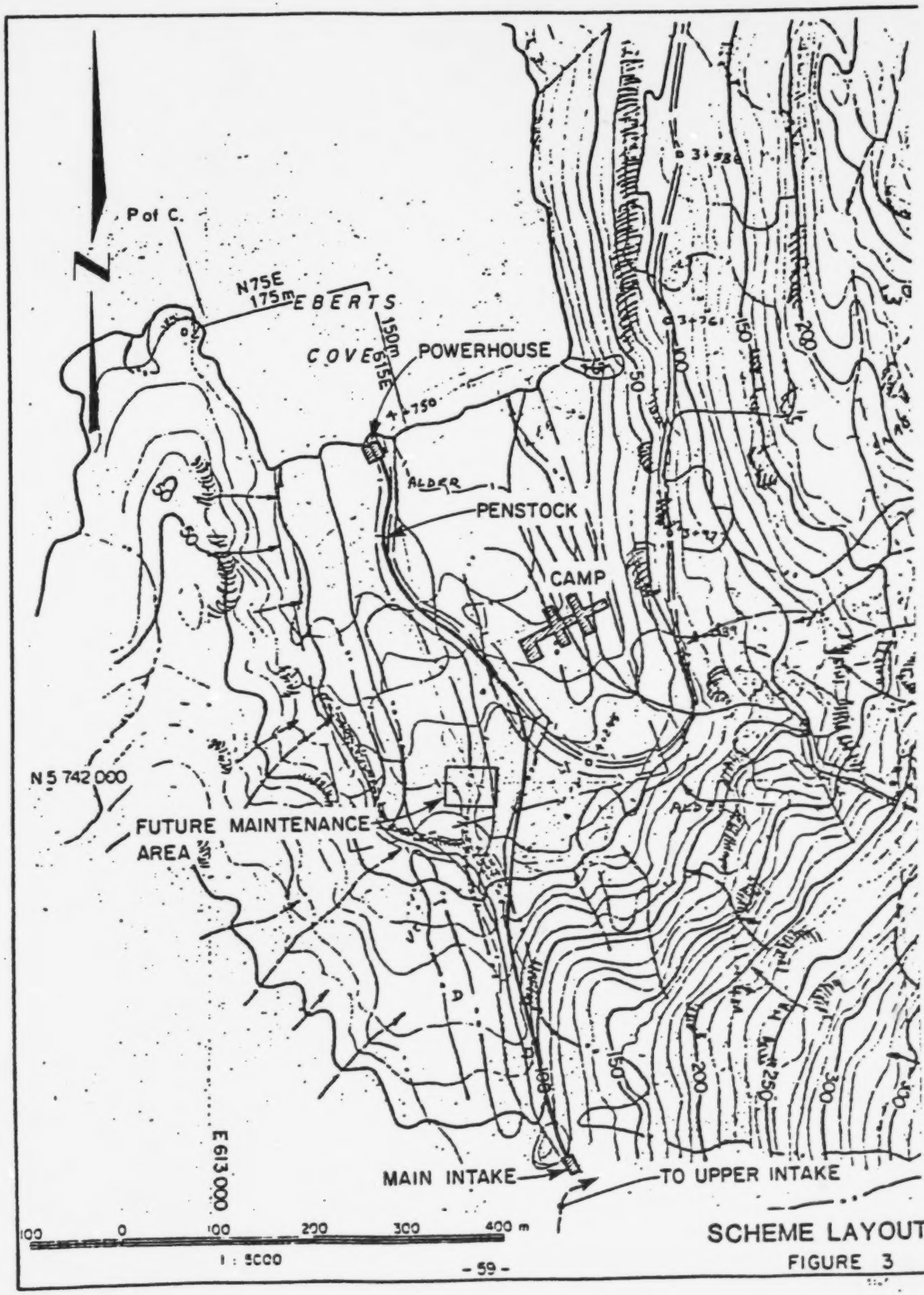
SCALE 1/32" = 1'-0"

(BASED ON ARTISAN DRAWING)

CAMP BUILDING LAYOUT

FIGURE 2

5927



SCHEME LAYOUT

FIGURE 3

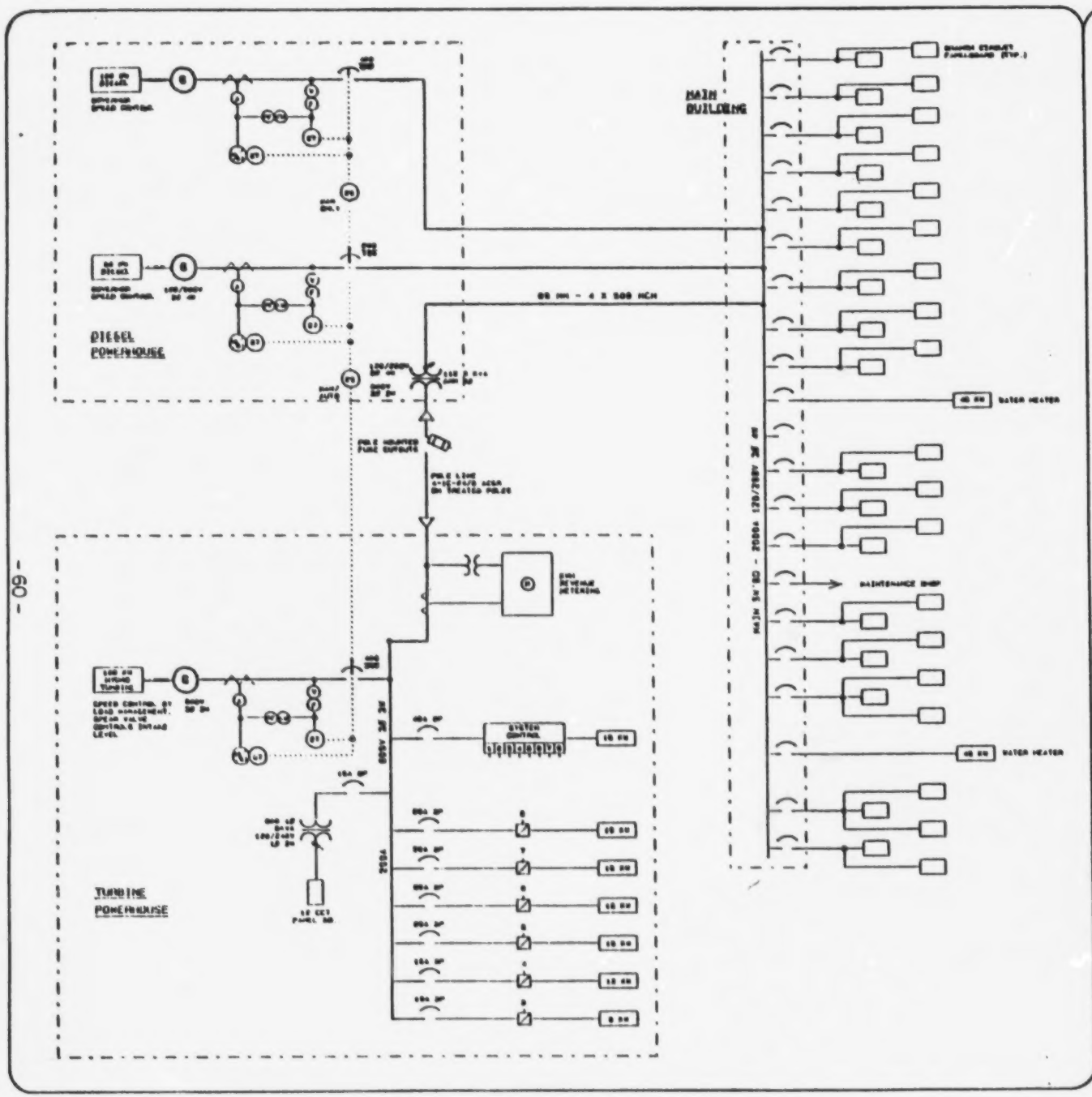


FIGURE 4

IAN HAYNARD & ASSOCIATES LTD.
CONSULTING ENGINEERS
NORTH VANCOUVER, VICTORIA

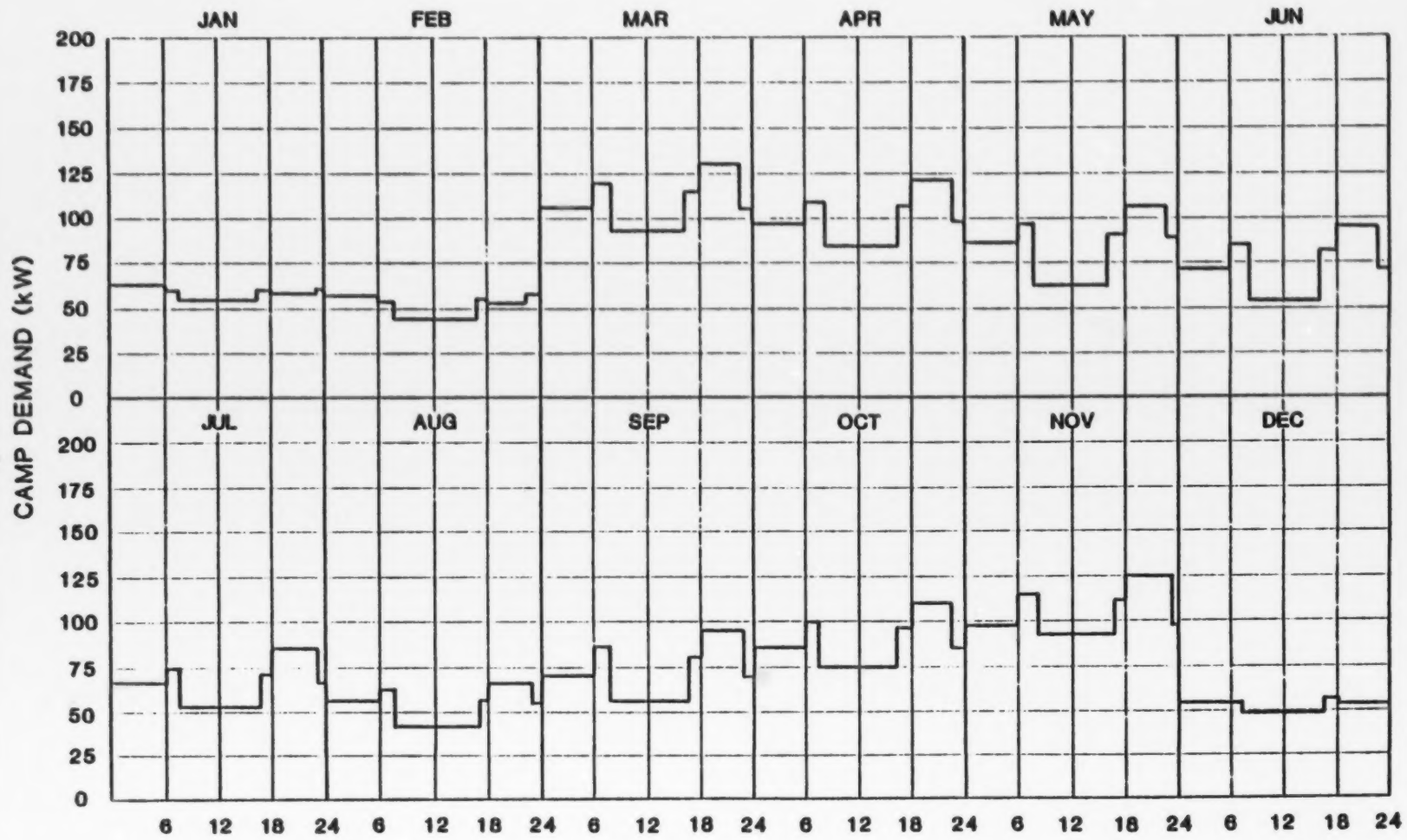
LANCASTER RESOURCE CORP.
HYDRO POWER - MOSES INLET CAMP
FEASIBILITY STUDY

TITLE
SINGLE LINE DIAGRAM
INTEGRATION OF HYDRO
GENERATOR (100 KW SHOWN)

DATE
02-84

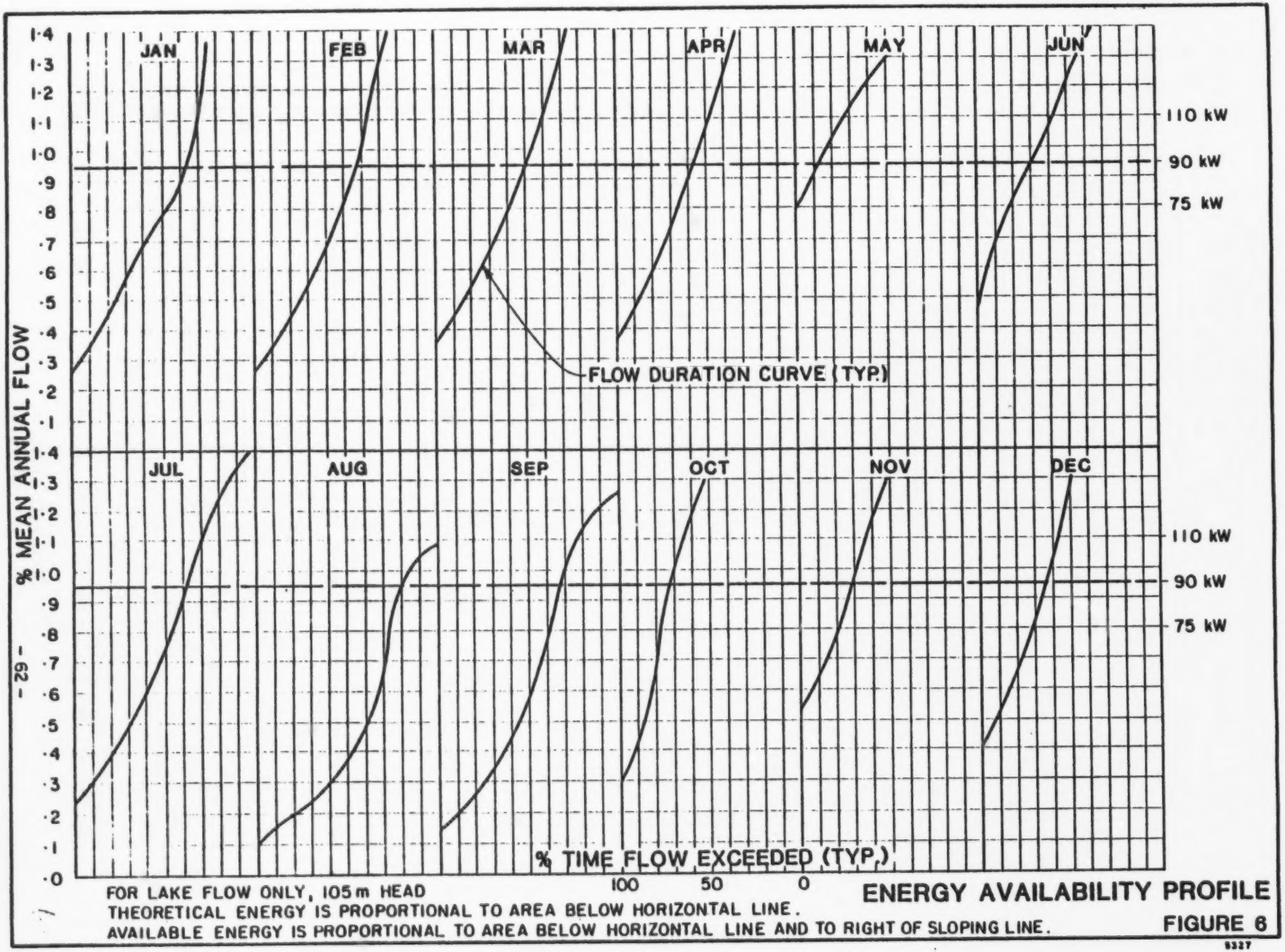
DRAWING NO.
SK-E1-8344

REVISION



Note: 70 man camp with energy management-estimated average daily loads shown
(Crew in camp March - November)

LOAD PROFILES
FIGURE 5

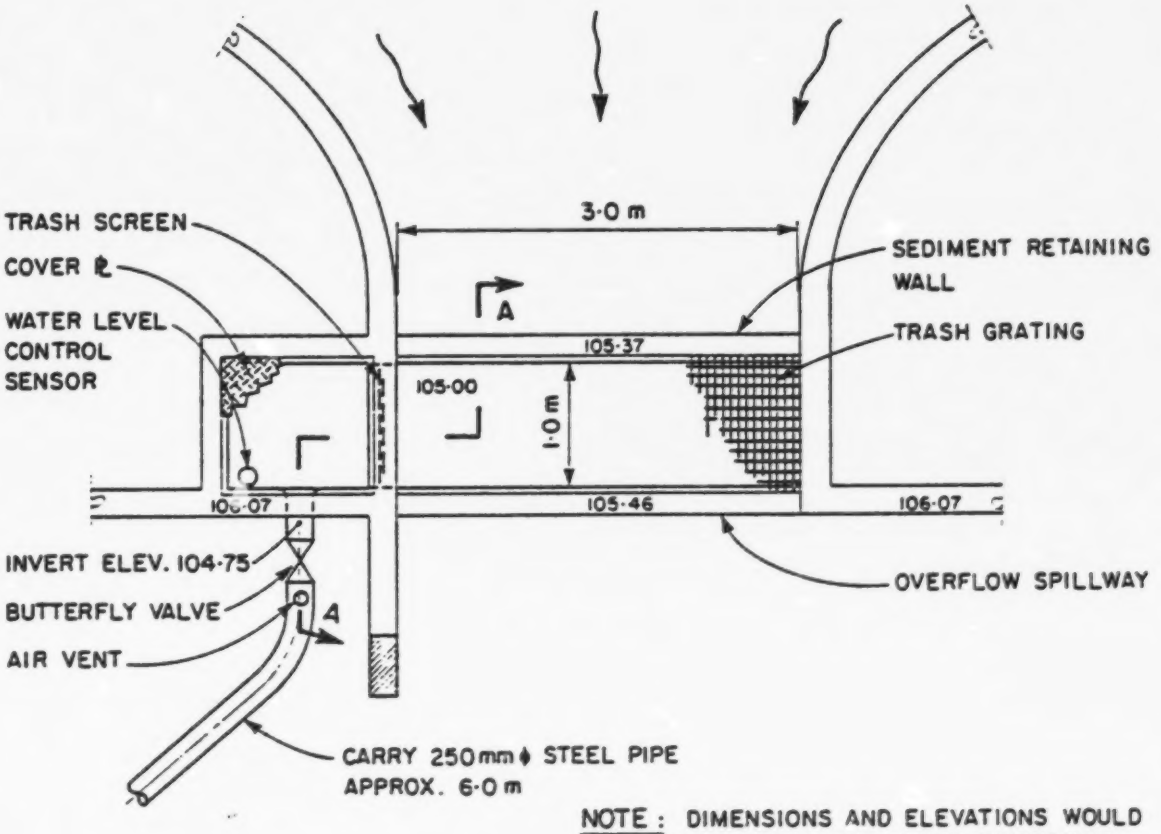


FOR LAKE FLOW ONLY, 105 m HEAD
THEORETICAL ENERGY IS PROPORTIONAL TO AREA BELOW HORIZONTAL LINE.
AVAILABLE ENERGY IS PROPORTIONAL TO AREA BELOW HORIZONTAL LINE AND TO RIGHT OF SLOPING LINE.

ENERGY AVAILABILITY PROFILE

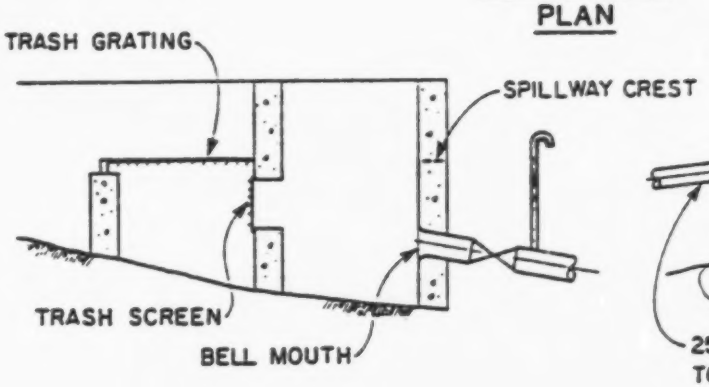
FIGURE 6

8327

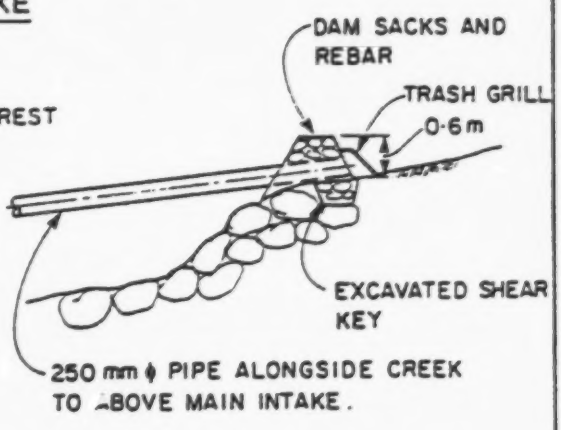


NOTE : DIMENSIONS AND ELEVATIONS WOULD CHANGE SLIGHTLY FOR DIFFERENT CAPACITIES.

MAIN INTAKE
PLAN



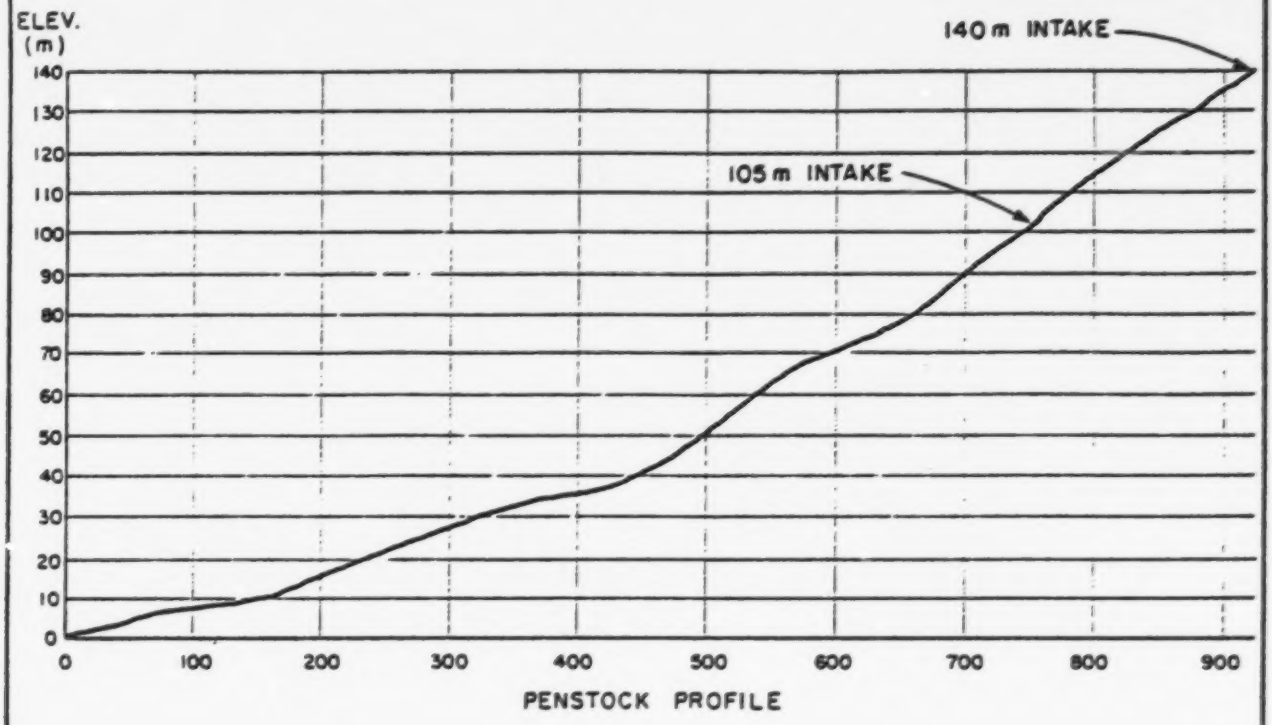
SECTION A-A
(NTS)

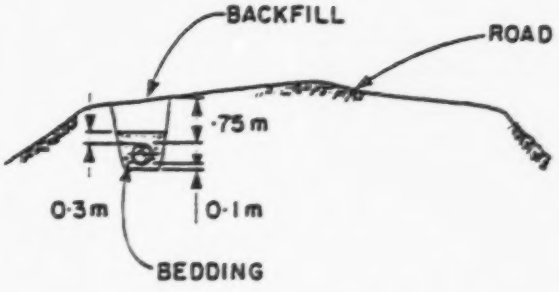


SOUTH CREEK INTAKE
PROFILE

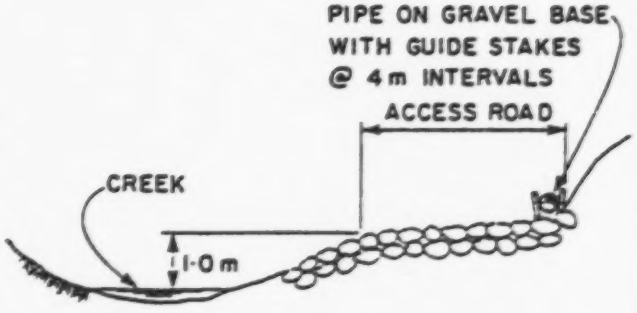
INTAKE DETAILS

FIGURE 7





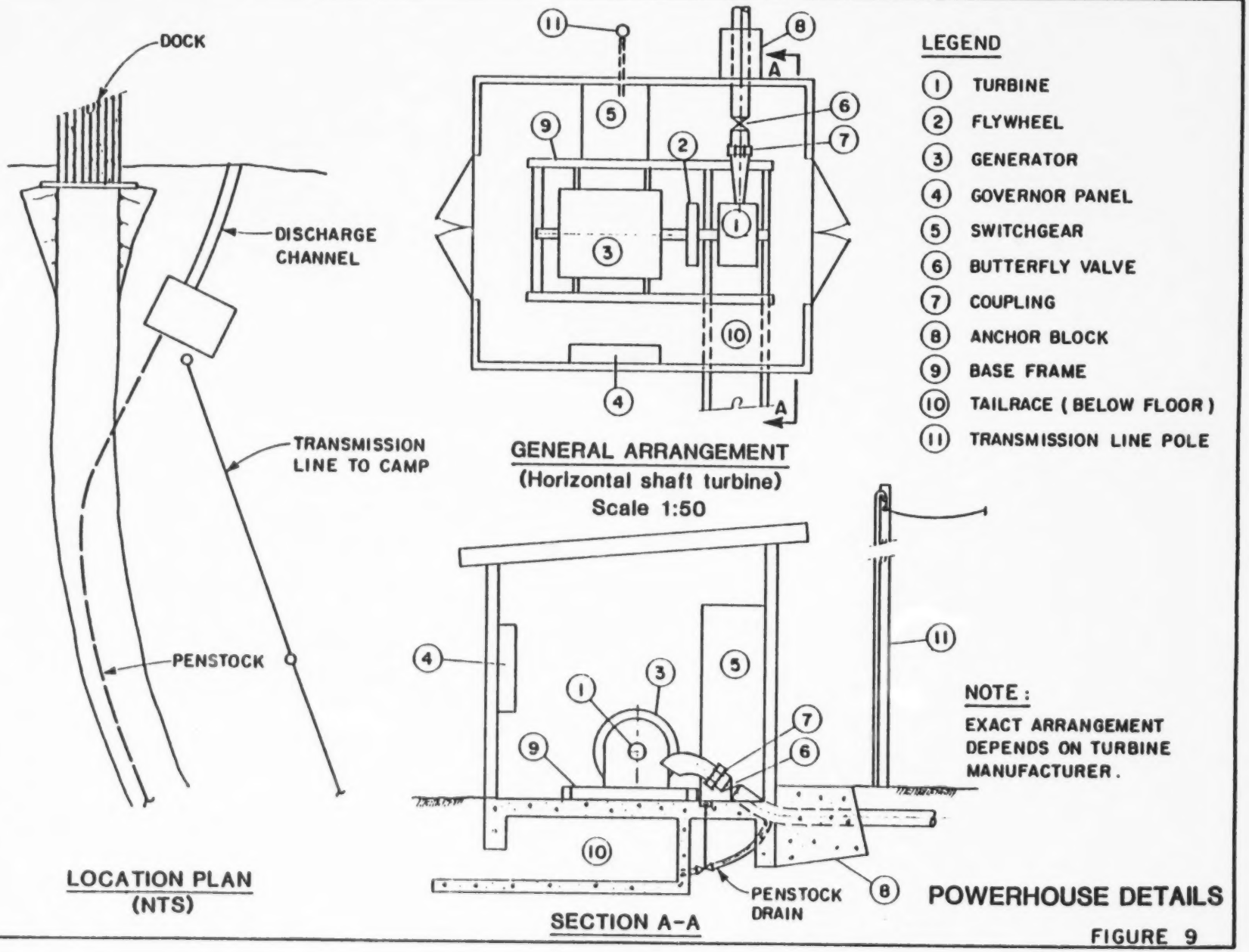
TYPICAL SECTION - BELOW GROUND
(NTS)



TYPICAL SECTION - ABOVE GROUND
(NTS)

PENSTOCK DETAILS

FIGURE 8


DOCK
DISCHARGE CHANNEL
TRANSMISSION LINE TO CAMP
PENSTOCK
LOCATION PLAN
(NTS)
GENERAL ARRANGEMENT
(Horizontal shaft turbine)
Scale 1:50
LEGEND
1 TURBINE
2 FLYWHEEL
3 GENERATOR
4 GOVERNOR PANEL
5 SWITCHGEAR
6 BUTTERFLY VALVE
7 COUPLING
8 ANCHOR BLOCK
9 BASE FRAME
10 TAILRACE (BELOW FLOOR)
11 TRANSMISSION LINE POLE
NOTE :
EXACT ARRANGEMENT DEPENDS ON TURBINE MANUFACTURER.
PENSTOCK DRAIN
SECTION A-A
POWERHOUSE DETAILS
FIGURE 9

APPENDIX 1

BACKGROUND TO TABLES

INTRODUCTION

Some of the tables shown in the report are based on computer outputs. The purpose of this section is to explain the information on the tables so that the development of the report can be followed more clearly.

Tables 3-1, 4-2, 4-3, 6-1 and 7-1 can vary with selected inputs. Therefore one representative input is shown in the report, but several are required in order to show all the options examined.

Table 3-1 - Energy Availability

This table compares the theoretical and potential energies available in the stream. The flow duration curve is input in increments of 1/10 month. Then the energy histogram is developed using the lesser of the design hydro power plant flow or the stream flow. The values (in percent of mean annual flow) are converted to the monthly available energies and summed.

The second part of this table compares the plant output throughout the month with the camp demand in each of six intervals representing daily activity levels. The lesser values of potential generation or load are summed to give the expected energy. Firmness is a measure of the potential energy of the stream related to plant size while load factor measures the predicted output against the maximum capacity.

In the examples shown, the energy is produced by a 90 kW hydro power plant at 105 m head and energy management is used in the camp. This gives a projected long term average generation, which is optimistic because many other factors tend to reduce the energy used as described in Table 7-1.

Table 4-1 - Summary of Electric Loads

This table was prepared following a survey of the camp electrical devices. It provides an upper range of loads on the electrical generation system and clearly indicates the dominance of water and space heat loads, especially in the event of a cold start.

Tables 4-2/4-3 - Load Pattern With/Without Energy Management

The camp loads are analysed in these tables, based on the estimated seasonal load patterns of various camp components and the crew size in each month. Some loads, such as common area lighting are essentially constant no matter what the camp size while other loads, such as water heating and individual room lighting, vary directly with the number of men in camp. Adjustments can be made to this table depending on the planned crew size. The case "Without Energy Management" is based on the unregulated use of the existing high capacity water heaters, such that when water is used it is reheated at full output until the set point is again reached. "With Energy Management" these heaters are heated gradually over the day, which is acceptable because most major water demands (showers and laundry) only occur once per day.

Table 6-1 - Costs of Various Size Ranges

This table presents the component costs of various hydro power plants ranging from 75 kilowatts to 180 kilowatts. The first purpose of the table is to evaluate total costs of each option. The component costs are either entered directly or transferred from the data below.

The second purpose of the table is to provide a ranking of the prospective plant sizes based on their load factors. The load factors are calculated for each pair of flow fractions and plant sizes, then entered into Table 6-1. The load factor represents the number of kilowatt hours per year generated, while the annual cost of the plant is taken as (total cost x capital recovery factor + maintenance). Then the cost per kilowatt hour is found by taking the Annual Cost/Annual Energy. The development cost (6% - See Table 6.3) has been included with the total cost.

With the plant sizes evaluated the range of feasible plants is defined so that subsequent variations are taken over a narrower range, as shown in Table 7-1.

Table 7-1 Costs of Alternative Scenarios

Table 6-1 was used to find the optimum range of plant size given simple construction and operating conditions. Table 7-1 uses the same format, but accounts for the effect of variables on the hydro plant production figures. The variables include:

- without energy management, where peak water heating loads are applied at the time of day they would normally occur;
- without south creek intake, where the cost savings of deleting the south creek intake is weighed against the energy loss;
- maintenance and downtime, where a percentage of the operating hours of the hydro power plant are reduced, resulting in a decrease in power output and an increase in average cost;
- a 10/4 day shift, in which the reduced load resulting from the entire crew going on leave for four days every two weeks is accounted for in the load factor;
- diesel load share, where the effect of letting the diesel plant take at least half its load capability when the capacity of the hydro power plant is limited during times when there is insufficient flow or insufficient installed capacity to meet the demand;
- lake flow improvement, where the additional cost of an outlet control structure on the lake is compared with the additional energy provided.

The above variables are tested against the base case over the range of least cost schemes, both to see if the ranking will change and to measure the cost index, which closely represents the cost of power. The cases are evaluated for full camp occupancy from March - November and a capital recovery factor based on 12% interest and 10 year amortization.

The last entry in the Table has been based on the combination of factors which are considered to be most realistic which includes a 40 man camp, occupancy from March to November, energy management, 5% downtime for maintenance and one intake on the creek below the lake outlet at the 105 m level. The project is amortized over 10 years and allowances have been made for maintenance and the developers on going administration costs.

APPENDIX 2

REGULATORY PROCEDURES:

LAND, WATER, FORESTS

One of the first steps in the process of constructing and operating a small hydro power plant, after establishing a power sales contract, is to secure land and water rights for the site. Accordingly, enquiries have been made to the Land, Water Management and Forestry branches of the provincial government regarding the project, and their replies are attached.

Province of
British Columbia

Ministry of Lands,
Parks and Housing

Regional Director
Room 201
172 North Second Avenue
Williams Lake
British Columbia
V2G 1Z6

RECEIVED FEB 2 0 1984

5327

February 15, 1984

Your File: 5327

Sigma Engineering Ltd.
801 - 1155 West Georgia Street
Vancouver, B. C.
V6E 3H4

Attention: G. S. McDonnell

Dear Sir:

Reference is made to your letter of January 6, 1984 re: Moses Inlet Hydro Power Project, Eberts Cove, B. C., a copy of which was forwarded to the Ministry of Lands, Parks and Housing from the Ministry of Forests.

It will be required that a right-of-way for a hydro distribution line be established from the power house to the main camp. Please find enclosed an application form to be submitted with a sketch map showing the width and length of the proposed route. There is an application fee of $25 (cheque or money order payable to Minister of Finance) and it is anticipated there will be a minimum rent levied at $200/annum for the easement.

Kindly return the application at your convenience. You may expect a processing period of 120 days for your application.

Should you have any further questions in this regard do not hesitate to contact the undersigned.

Yours truly

I. Kondor
Land Manager

IK/bh

Province of
British Columbia

Ministry of
Environment

Water Management
Cariboo Region
540 Borland Street
Williams Lake, BC
V2G 1R8

YOUR FILE 5327
OUR FILE 55.3020

RECEIVED FEB - 6 1984

January 25, 1984

Sigma Engineering Ltd.
801-1155 West Georgia Street
Vancouver, B. C.
V6E 3H4

Attention: G. McDonnell, P. Eng.

Dear Sir:

Re: Moses Inlet Hydro Power Project, Eberts Cove
and your letter of January 6, 1984

The information you requested is addressed below in the sequence in which it was listed.

- There are no existing water licences or applications on the streams you indicated.

- A variety of steps may be required in order to obtain the necessary permits, however from Water Managements point of view the first step, is to make application for a water licence* after which you will be required to supply all information necessary for investigation and processing of the water licence. It is unknown exactly what will be required in the way of additional information but could for example involve anything from; an explanation why the project is needed to detailed design drawings, etc.

  In your letter you mention that a private developer would install and operate the plant under a power supply contract to the logging camp. Depending upon the circumstances, (i.e. who owns the Hydro plant and the land on which it is situated, etc.) a water utility may have to be formed. This may involve more redtape than you were expecting and therefore you may wish avoiding it by having the logging company own all the works and just contract out strictly the construction and operation of the power project to another company.

... 2

- The lead times are like the "steps" above in that they are dependant upon the complexity and completeness of the project proposal. It is not uncommon for a water licence to take up to two years and more to be issued and construction approved. However this period can usually be shortened by the applicant supplying complete and accurate information and dealing on a one to one basis with the technician responsible for the area of your project.

The fees for application and annual rentals have just recently been changed and we do not yet have the figures in hand, however details can be obtained by calling or writing to our Victoria general office at 765 Broughton Street, Victoria, B.C. V8V 1X5, phone number 387-5981.

In this office your contact is Garth Wakelam who can be reached at the letterhead address or by calling 392-6261, local 298. If you have any further questions please feel free to call.

Yours truly,

Ron B. Smith, P. Eng.
Regional Water Manager

GKW/lb

Enclosure*

Please note change of address to:
Ministry of Environment
Water Management
540 Borland Street
Williams Lake, B.C.
V2G 1R8

Province of
British Columbia

Mid Coast Forest District
P.O. Box 190
Hagensborg, B.C.
V0T 1H0

RECEIVED FEB 14 1984

February 6, 1984

YOUR FILE: 5327

Sigma Engineering Ltd.
801 - 1155 West Georgia Street
Vancouver, B.C.
V6E 3H4

Dear Sir:

In reference to your correspondence dated January 6, 1984, regarding your proposal of supplying power to Moses Inlet Logging Camp.

-Our reference maps indicate the only tenure within the areas outlined on supplied maps is Special Use Permit 9799 covering Crown Forests Eberts Cove Logging Camp.

Since you are classified as a non-forest user the Ministry of Forests is not responsible for issuing tenures covering this development. As such I have talked with the Ministry of Lands Parks and Housing in Williams Lake and forwarded them a copy of the application sent to our office.

Once you have secured tenure on the area required you will need a Licence to Cut to cut and remove trees for lines, buildings etc. Enclosed you will find three copies of Application for Licence to Cut that should be completed and returned to this office for processing. Along with the completed applications please enclose a photocopy of your lease or licence so as to speed up processing of your licence to cut which should take app. 2 months.

If you should have any questions in regard to this matter feel free to contact this office at 982-2621; your contact person is Chris Schmid.

Yours truly,

Chris Schmid

Chris Schmid
Timber Coordinator

CS/ks
Encls.